Mechanics World

AND ENGINEERING RECORD

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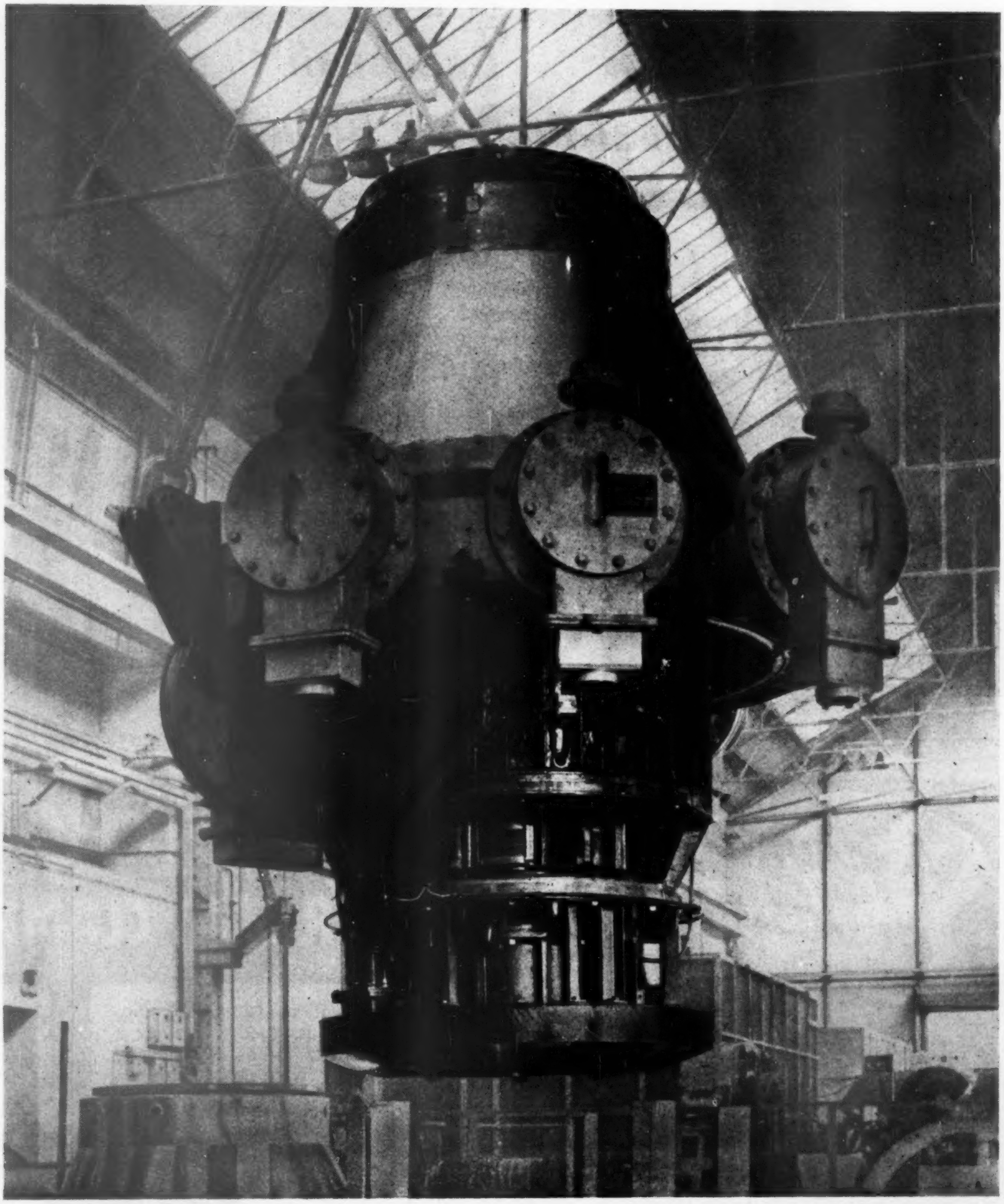

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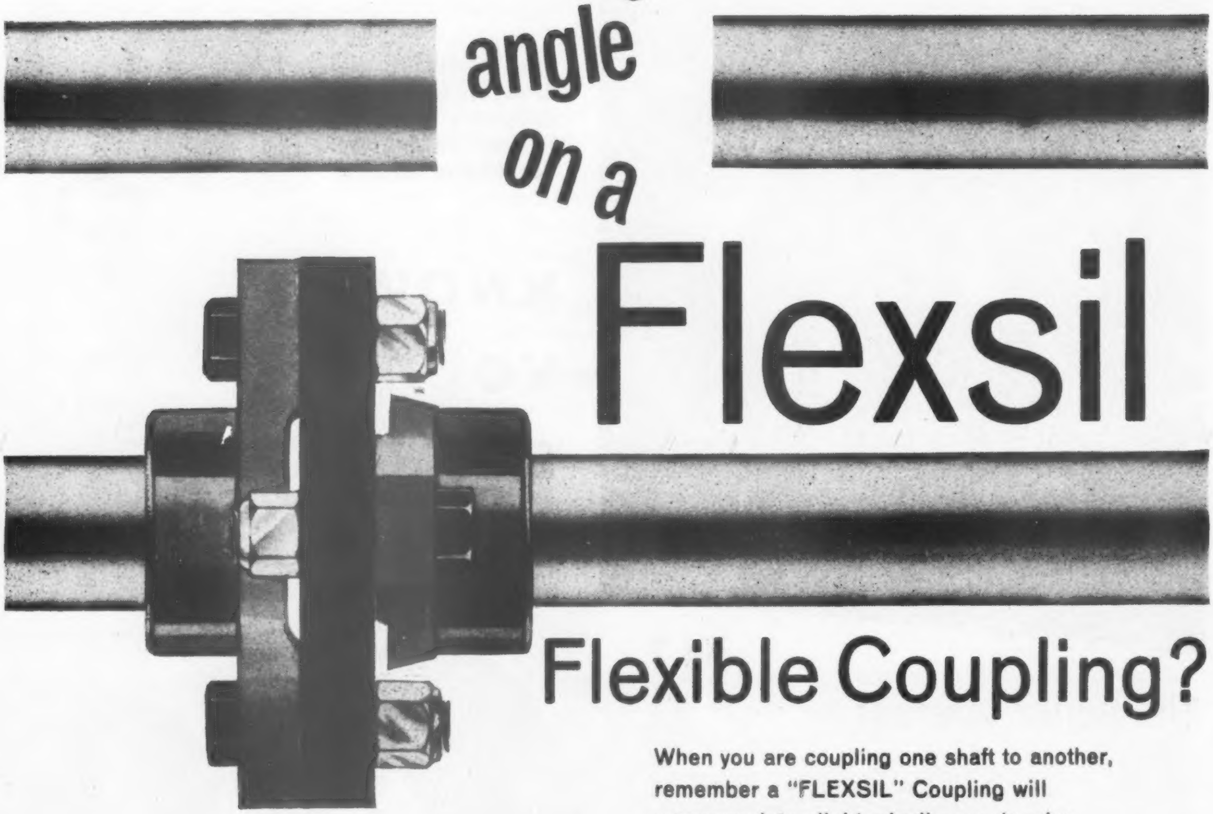

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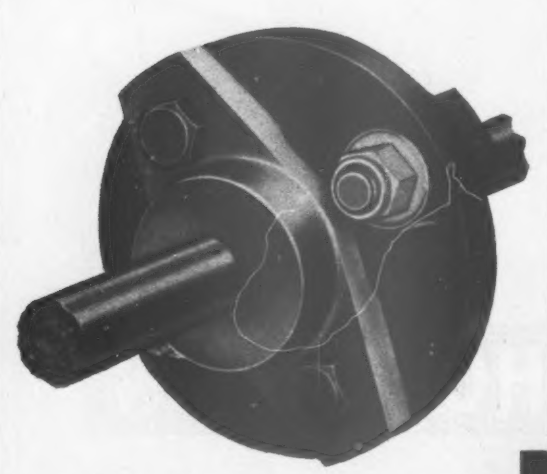

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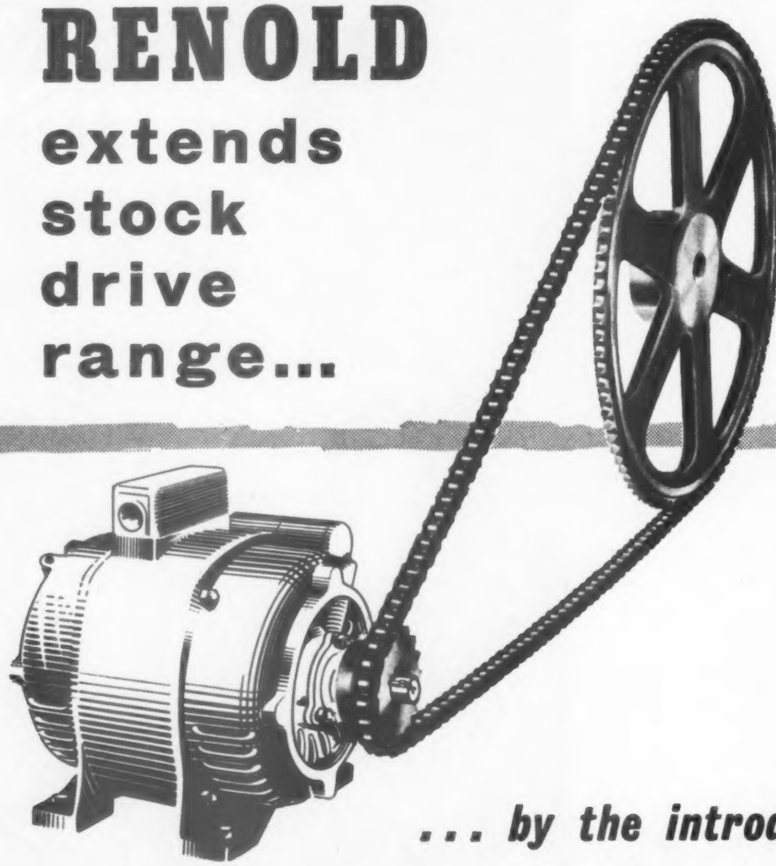

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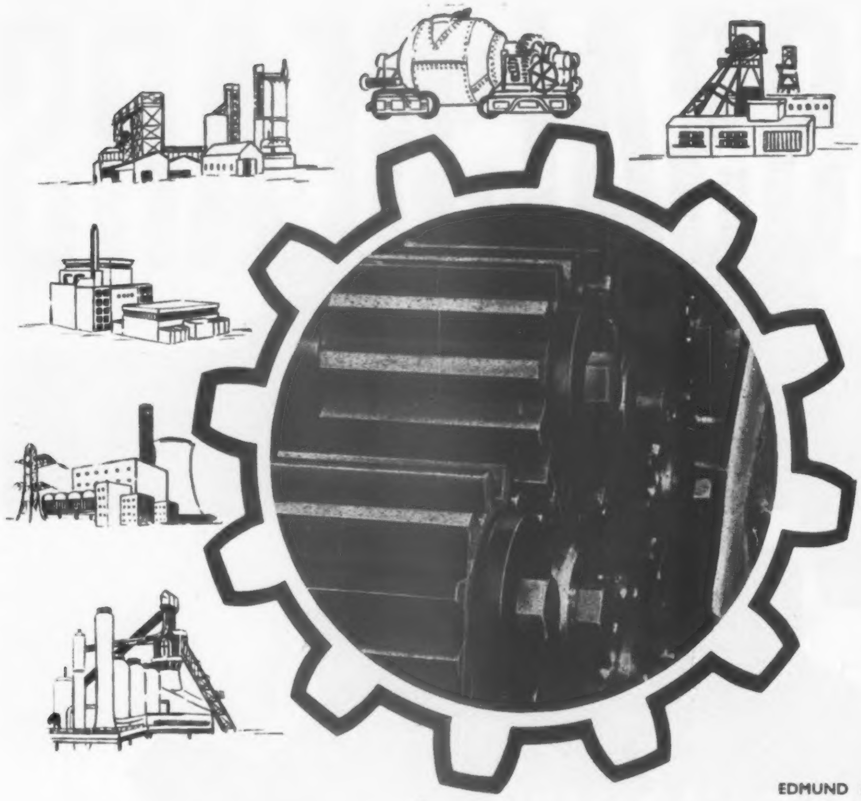

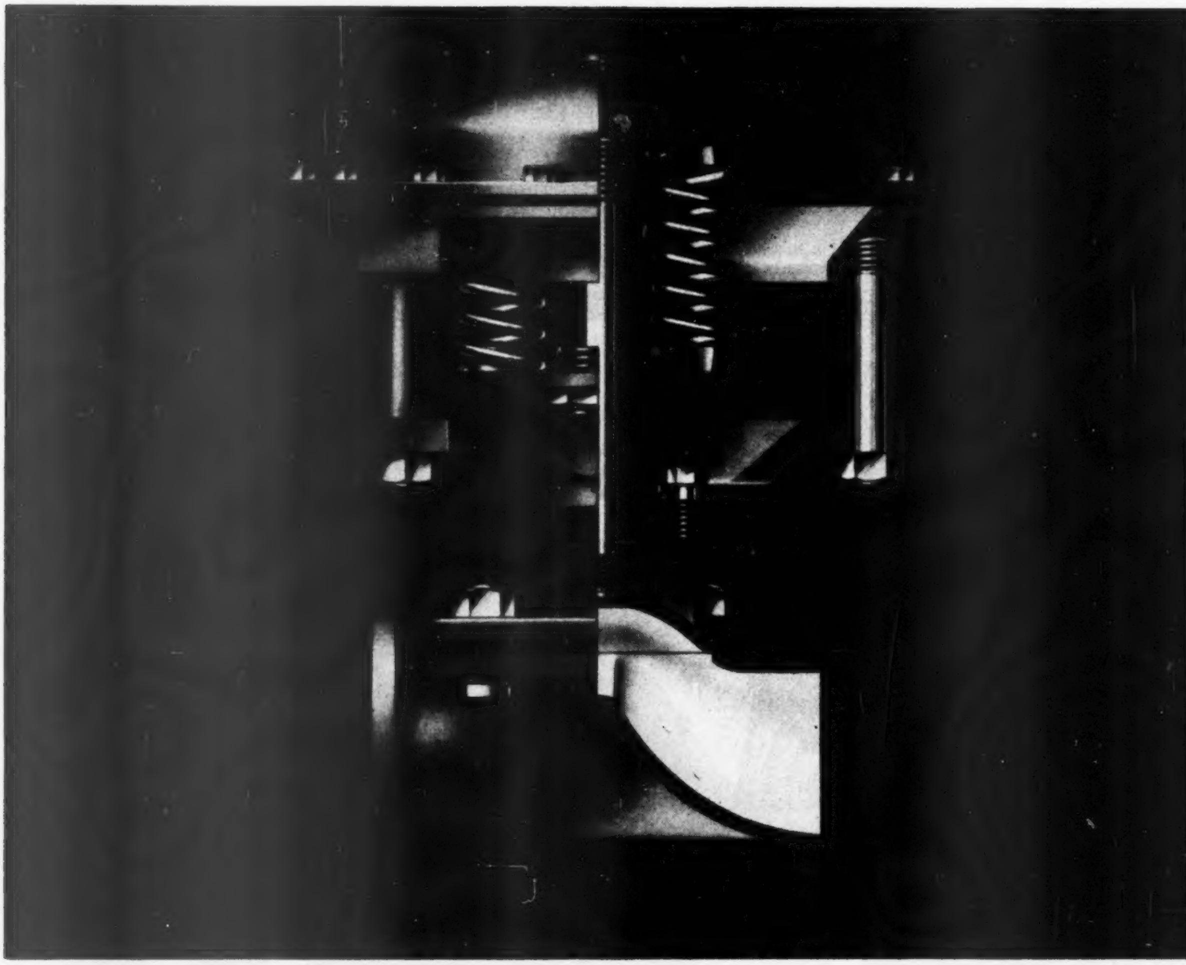

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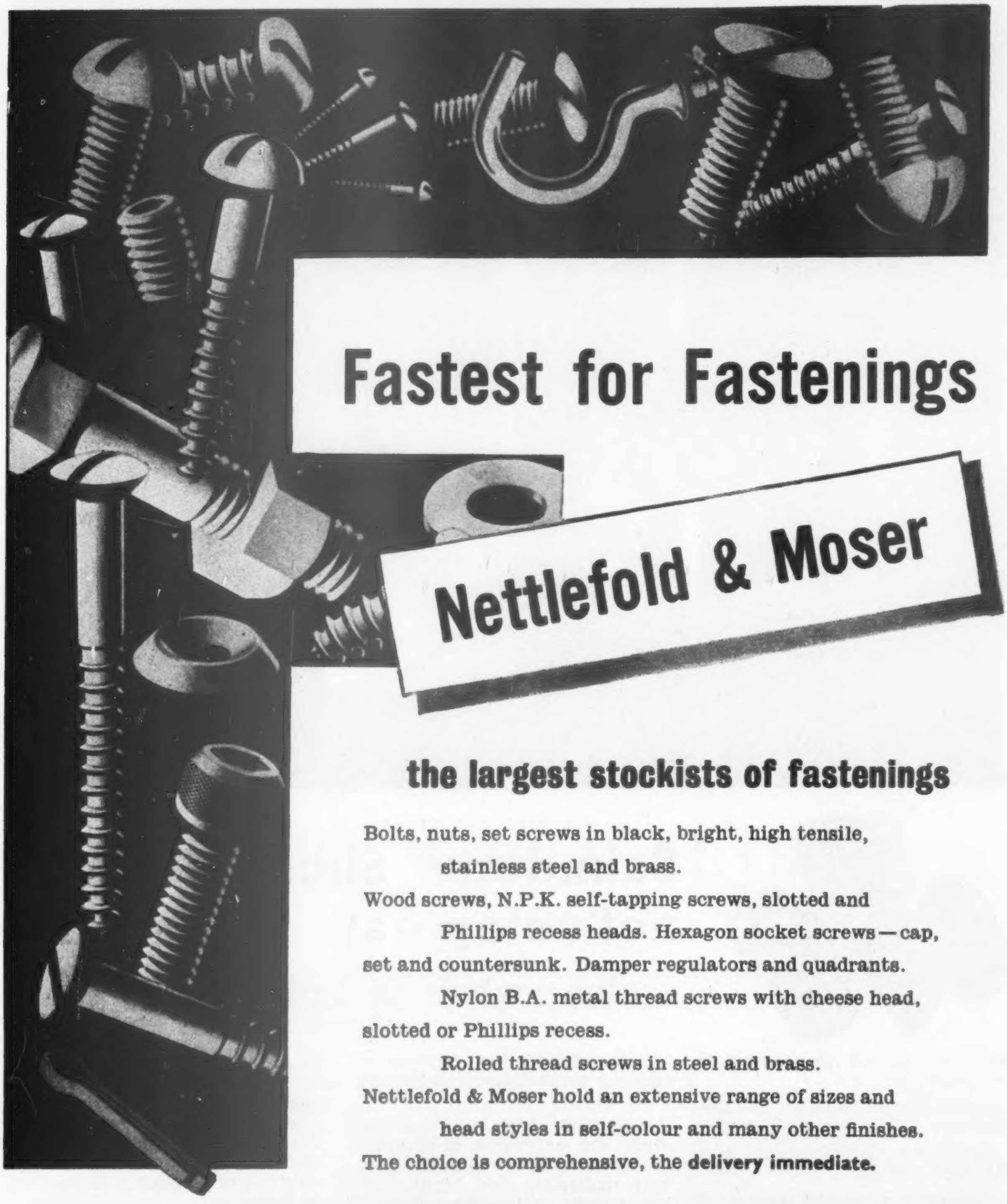
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Left—Tooling a 17 in. dia. alternator shaft at a hydro electric power station in Malaya.

Right—Honing a 33 in. dia. ball mill trunnion at Billingham.

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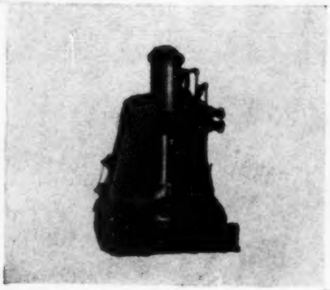

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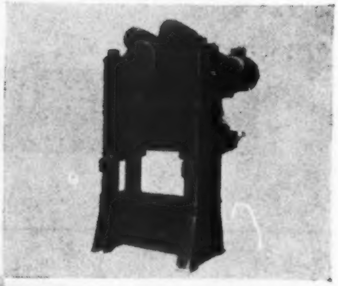

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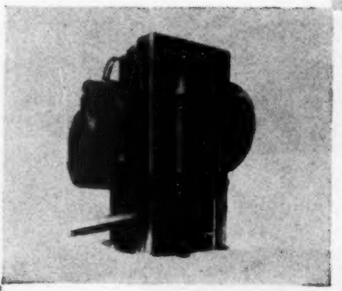

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Mechanical World

AND ENGINEERING RECORD

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Contents

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Safety in Skill

DESPITE all the work put into accident prevention the number of industrial accidents continues to grow, and accidents to young persons are becoming distressingly more frequent. Yet it is on record that many injuries have been prevented by special clothing, machine guards, and the like. There is no record—nor is there ever likely to be one—of accidents prevented by conscious avoidance resulting from training and accident prevention propaganda.

There are factories where the frequency of injury has been reduced and sometimes eliminated—for a time anyway. This may have been achieved by taking "accident control" away from the worker and embodying it in the machinery or in preventive devices. Or it may have been done by knowledgeable selection of personnel and by culling of the accident-prone types—for people do vary greatly in susceptibility to accident.

The biggest problem must be where large numbers are employed and where, consequently, there is constant recruitment. There is no obvious accident-free characteristic of the human being and dependence must be placed upon propaganda and training, and in the use of preventive clothing and devices. As long as the human being is concerned in the success of these elements the result will be variable. For example, there are three ways of driving a nail into wood. One is to stand the nail upright and drive it hard before it can fall over. Done expertly this is extremely quick. The snag is that every now and then a nail will be hit slightly obliquely and it will fly off with the impetus of a nearly lethal projectile. The second way is to hold the nail upright, tap it into the wood, and when it is secure, drive it by heavy blows. This is sure, safe, but slow. The third way is by nailing gun or nailing machine. This is both safe and fast when it can be used. Where hand nailing must be done, the problem is how to prevent the second method, presumably used in training, changing imperceptibly into the first with the acquisition of skill. The skilled hand works so quickly and the human brain works, relatively, so slowly, that continuous conscious control cannot really be expected. Within the circumstances of the example it would seem that what is necessary is some technique which has to be learnt and which is necessary to the natural growth of skill, and which has in it as a fixed essential an element of control such that *all* nails must be driven and so that none escapes.

This is but one example, and a simple one, but it has in it a principle which is obviously applicable wherever human "interference" enters into an industrial process. It poses all kinds of problems, not the least being how to identify safe manipulation with the optimum (and therefore natural) growth of skill. This touches a realm on which little is known, but of which something is at least now being learnt—human psychology and bodily motivation. The trouble is, that there is so much to correlate and to analyze—altogether too many factors to deal with. The same trouble arose in the design of nuclear power plants, but it was overcome with the aid of the computer. Now that neurologists are interested in these machines is it too much to hope that before long they will be used by industrial psychologists also to study human behaviour in the interests of just this one important problem of how to build accident freedom into the acquisition of skill?

LOG SHEET

H.M.S. Ashanti

The first of the new Tribal Class frigates *H.M.S. Ashanti* has combined steam turbine and gas turbine boost/propulsion machinery designed in conjunction with Yarrow-Admiralty Research Department and manufactured by Associated Electrical Industries Limited.

The steam turbine provides power for normal cruising and manoeuvring and when high speeds are required, the G6 gas turbine geared to the same propeller shaft—developing full power within minutes of starting—comes into operation. An even more important feature of this gas turbine is that it can enable the ship to get underway at a few minutes notice when steam is not available.

The gas turbine, specially developed for naval boost propulsion, has a rated output of 7500 shp at 59° F ambient air temperature. Two 2-stage turbines are arranged back to back, one driving a 13-stage axial flow compressor and the other the output shaft. The gas turbine runs on distillate fuel burnt in six flame-tube combustion chambers and heavy fuel oil can be used in an emergency.

Rotary Gravel Screens

The manufacture of perforated screens is highly specialized and one of the largest producers in Britain is G. A. Harvey & Co. (London) Limited, Greenwich, who produce each year many hundreds of perforated plates and rotary drum screens for the sand and gravel industry.

Some rotary screens have cylindrical drums and other conical ones, but in all cases the sheet steel is perforated with the required holes while flat. Round holes, square holes, or round-end slots of the size and pitch that the user calls for are accurately punched in the steel plate, which may be up to $\frac{1}{2}$ in. thick. The screen plates are then rolled to the correct shape and bolted or welded together to form the complete drum. A reinforcing band of steel is bolted or welded round the rim at the discharge end, while a ring of steel angle is fitted at the intake end where the drum is bolted to the rotating mechanism of the screening machine.

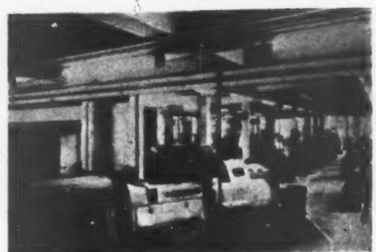
Bolting together the six tapered sections of a conical rotary gravel screen at the Greenwich works of G. A. Harvey & Co. (London) Limited

In the example illustrated, the 8 ft long screen drum is conical, tapering from 5 ft 3 in. to 6 ft 8 in. dia. The $\frac{5}{16}$ in. thick steel plates have been perforated with 1 in. dia holes at $1\frac{1}{2}$ in. centres. Six tapered sections are being bolted together and the reinforcing band at the discharge end has already been fitted. The angle ring at the intake end has yet to be fitted and then the completed screen will be ready for use. Depending on the throughput and abrasive qualities of the material being graded, the screen should give many months of satisfactory service before gradual erosion of the metal increases the hole size and replacement becomes necessary.

Tool Department

To meet the demand for increased factory space and machine capacity in their engineers' tool department, James Neill & Co. (Sheffield) Limited, makers of Eclipse tools, have erected a new four-storey block designed to minimise handling throughout production.

On the ground floor is situated the raw material section which can accommodate the largest delivery vehicles and handle and store all incoming material. In the adjacent machine shop are six-spindle and single-spindle automatics and an extensive capstan section as well as heavy vertical millers and shaping machines. Offices and general store are situated on the first floor, together with the maintenance and cutter grinding section and a machine section consisting of vertical and horizontal milling, drilling and broaching machines, centreless and surface grinding machines and light presses. On the second floor in addition to the main progress store and the planning office is a machining section for light secondary operations. The third floor houses the assembly section and the heat treatment section which has furnaces equipped with the latest pyrometric control.



Automatic and capstan section in the new Eclipse tool making department

The department is light and airy with controlled temperature heating; there is a 'roominess' throughout with safety lanes clearly marked. Between floors, ample elevator accommodation ensures service between the various levels.

Research Register

In 1960, the Production Engineering Research Association made a special study of the need which exists for a world register of production engineering research to assist research workers and production engineers to keep fully informed about investigations carried out in research organisations, industrial firms, universities and colleges throughout the world. Proposals based on this were subsequently presented to the general assembly of the International Institution for Production Engineering Research (C.I.R.P.), which unanimously agreed that C.I.R.P. should proceed as quickly as possible with the compilation of the register and that the extensive work of translating, editing, classifying and disseminating all information to be incorporated in the register should be entrusted to PERA.

The world register will cover all production research carried out in the years 1959-62, and will summarise plans for research for the following three years. The main subjects to be covered are: automation, machine tools, materials handling, finishing processes, metal forming, assembly, inspection and measurement, metal cutting, machinability and formability of materials.

The register will give as much information as can be obtained about establishments carrying out programmes of research revelant to production engineering, including details of the researches undertaken, the staff,

workshops, laboratories, special facilities and equipment. The survey is also expected to provide information on publications, educational services, etc. This information will be sought by means of a questionnaire which is now being sent to research establishments. Organisations carrying out any form of production engineering research are invited to write to the information manager, PERA, Melton Mowbray, Leics. for a copy.

PEINE TOWER CRANE.—This 10-ton capacity free travelling Peine tower crane, weighs 200 ton and is one of two made to Taylor Woodrow's special requirements in Germany for use at Sizewell nuclear power station being built by the English Electric, Babcock & Wilcox, Taylor Woodrow atomic power group. When fully erected the height from ground level to mast top will be 220 ft and, with the lifting boom raised to its limit 320 ft. The crane "builds" itself by a hydraulic lifting device, which raises the mast sufficiently to enable an extra 15 ft section to be inserted, the entire operation taking less than three hours. Additional sections are inserted at the bottom. The crane is capable of lifting a maximum load of 10 ton—5 ton at maximum radius of 164 ft. It is mounted on its own rails, and is electrically operated

Fuel Cell Development

Three British companies, The British Petroleum Company Limited, British Ropes Limited and the Guest, Keen, Nettlefolds Group, with combined total assets exceeding £700 million, have joined with the National Research Development Corporation to form a new company, Energy Conversion Limited, to promote research into the development of fuel cells.

Research into fuel cells has been carried out in this country with the support of the N.R.D.C. over a number of years. Although working versions have been demonstrated, none has yet been produced commercially. Various other British, German and Scandinavian organisations are also known to be working in this field, in which interest has increased markedly in recent years, notably in the United States. Probably the most advanced work is that now being carried out jointly by the United Aircraft Corporation of East Hartford, Connecticut, and the Leesona Corporation, of Providence, Rhode Island, with whom the N.R.D.C. has reciprocal arrangements.

New David Brown Tractor

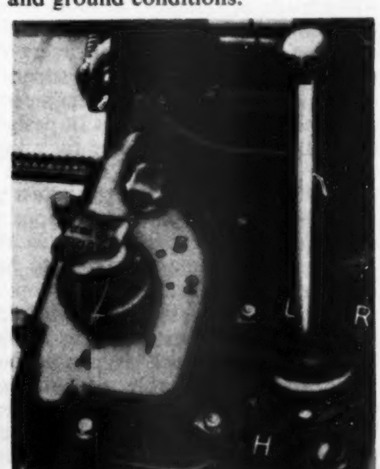
The David Brown 990 Implematic tractor has a three-litre diesel engine giving the machine a maximum of 52 bhp, an increase of 10 hp over the previous most powerful model. At just under two ton dry weight (2 ton 15 cwt total ballasted), the 990 has the highest power-to-weight ratio of any David Brown tractor ever built. The four cylinder engine has a bore of 3⅝ in., a stroke of 4½ in., and a compression ratio of 17:1.; wet cylinder liners are used. A 1⅝ in. dia splined extension shaft at the front of the crankshaft is capable of transmitting the full engine power for auxiliary drives.

A new two-ratio power take-off unit is provided to enable tractor and implement alike to be operated at the optimum running speed according to working conditions.

The 990 is available in two models one with single-stage clutch and the other a "Livedrive" model with two-stage clutch providing "Live" hydraulics and "Live" power take-off.

Shown at the Smithfield show was the David Brown Autodrive a new, simple form of automatic transmission, partly hydraulic but predominantly mechanical, which is built into a standard 52 bhp David Brown 990 tractor. This has two forward speed ranges—one giving 4 to 16 mph for light transport and road work, and the other providing speeds of 1 to 6 mph for specialist jobs like harvesting and cultivating. A further range of four reverse speeds is also available.

In operation the tractor virtually thinks for itself. The driver simply sets a dial to "Automatic" and then engages the selected speed range. The system selects the lowest speed ratio on starting from rest—thereby minimising the load on the transmission—and then changes smoothly, automatically and without pause to the highest and most efficient working speed possible according to the load and ground conditions.



Autodrive control with pointer at "automatic"

Progress with Engineering Plastics

The plastics industry is nearly a century old. The first commercial plastic was celluloid, synthesised as a substitute for ivory in 1868. Very little subsequent development of plastics took place until the beginning of the present century but the past decade has seen the general acceptance of man-made materials both for the mass production of consumer goods and as engineering materials in their own right. This article discusses some important aspects of modern plastics applied to engineering and in particular the newer plastic materials recently introduced on a commercial basis and offering superior characteristics to nylon

PLASTICS are unique as engineering materials not only on account of the limitless variety of man-made materials that can be evolved under the general term 'plastics', but also for the rapid expansion of techniques in handling these materials and the ever-increasing fields of application. No other industry, outside possibly electronics, has undergone such large scale development and expansion within the last decade. Within this period, too, plastics have become firmly established as engineering materials, rather than exclusively as materials for mass production of consumer goods of a non-critical nature.

The earliest plastics were produced as substitute materials. The very first plastic of all—celluloid—was developed as a substitute for ivory (and there was, at the time, a substantial prize offered to encourage research for such a substitute). This basic idea of regarding plastics as substitute materials persisted right through the first half of the present century, particularly as far as the engineer was concerned, although many of the materials obviously offered unique properties which could be used to show advantages compared with the materials for which they were being substituted.

Much harm was done at this stage by wrong application of plastics. The choice of commercial plastics available was somewhat restricted, and mechanical properties limited in many respects. Yet their obvious advantages, such as ease of fabrication in the form of moulded articles, led them to be used for applications for which they were not suitable. As such, the engineer came to regard plastics with suspicion—a feeling which still persists in some of the more conservative centres of traditional engineering. Yet modern plastics are essentially engineering materials in their own right, capable of offering equivalent or even superior performance as alternatives to traditional engineering materials, and also opening up new realms of design and manufacture. Like all materials they have their limitations but it is a feature of a man-made or plastic material that the molecule can be 'tailored' to adjust properties.

Continual development, therefore, results in continued improvement in properties. The list of available materials has, in fact, become so vast as to be confusing—to say nothing of the fact that common names, like nylon, are generic and designate a whole family of materials with varying properties. New applications are always being sought, as well as new materials, and many of these show remarkable advantages at relatively low cost. Keeping abreast of these developments is yet another problem for the present-day engineer-designer to face. Not a single industry can afford to ignore modern plastics, or the fact that there is always something new appearing.

Production techniques of plastic mouldings and the like have also developed rapidly during recent years. Currently, the largest plastics injection moulding machine has a capacity of 1,000 oz—well over half a hundredweight in a single shot, fabricated almost in a matter of seconds. Incidentally, shot-weight on injection moulding machines is usually expressed in terms of ounces of polystyrene and is adequate for most materials. With injection moulding powders similar to polystyrene, a bulk rating of 60% to 80% is commonly adopted as a safeguard.

Design problems associated with large capacity injection moulding machines are considerable, especially as the machine may be called upon to handle materials of widely different bulk factor, specific gravity, thermal conductivity and melting temperature. The fact that thermoplastics are poor conductors of heat also poses a problem to ensure satisfactory through heating (usually by breaking up the mass of the material into a small cross section). Moulding pressure, too, is a variable factor depending on the viscosity and temperature of the material and the maximum pressure which can be applied against a moulding of given area. Maximum injection pressure is usually of the order of 20,000 psi although the majority of mouldings are usually made at considerably lower pressures. The basic requirement is to transform the injection column from cold granules to a homogeneous melt (by heating) and then apply sufficient pressure to fill the mould, give good dimensional stability and a high surface finish. Excess pressure only produces stress-filled mouldings and detracts from the ease of ejection of the mouldings.

Extrusion techniques have also developed rapidly over the past few years. Basically this yields bar section or tubular stock, but in many cases it may be competitive with injection moulding as a production method. Extrusion, too, is now the standard method of producing plastic sheeting. Blow moulding, sludge moulding and vacuum forming are further techniques which have become highly developed and most versatile. The customer needs to know the virtues and respective costs of these different methods in order to be able to plan the most suitable and most economic production. Equally, the designer needs to be familiar with the techniques of production in order to be able to design the part to suit the production method and the material being used.

Not all plastic components, of course, are fully moulded. A considerable number of engineering components may be machined from bar stock, extrusions, or mouldings. The deciding factor is usually economy, depending on the difference between machining time involved and the tooling cost for a complete job. As a

general rule, machining is more economic when the annual value of production of the moulding does not exceed three times the tool cost for the part. On the other hand, machining may be chosen as producing a more accurate job. Nylon gears, for example, can be machined from rod by conventional methods, these giving greater accuracy than a moulding, especially if the thickness of the gear exceeds about ¼ in. On the other hand, injection moulding is usually perfectly satisfactory for small nylon gears (and appreciably cheaper for quantity production).

This comparative example, incidentally, exposes a further factor which is often ignored (usually because it is not appreciated). Treating nylon as a purely engineering material may lead to a decision to machine cut gears from bar stock in order to achieve the normal standard of accuracy to which the designer is used to working. In fact, nylon gears, due to their resilience, do not need to be made to the same limits as required for metal gears for equivalent performance. This lack of material 'know how' can lead to uneconomic solutions. It could also lead to trouble. Nylon may have an appreciable contraction on removal from the mould, the degree of contraction depending on the temperature at which the mould is opened. An operator on piecework may be tempted to speed up the cycle and produce a series of pieces which contract more than a later number ejected subsequently at a lower temperature. The correct choice of grade and, if necessary, strict process control will minimise such troubles.

The main lesson to be learnt in this respect is that with all the development on modern plastic materials and processing methods it is still easy to mis-apply a plastic for a given design through a variety of faults—wrong choice of material, poor design for moulding, lack of attention to moulding technique, lack of appreciation of any subsequent ageing effects, and so on. To apply plastics properly, in fact, one must *know* plastics and their particular idiosyncrasies.

Of the newer plastic materials nylon is undoubtedly the best known and the most widely applied for engineering applications. It has become almost as much a stock material as brass and steel. Used as an engineering material it must, however, be regarded as a *distinct* material with specialised properties and requiring specialised treatment. The same applies, in the main, to all the other plastics used as engineering materials or for critical applications.

Nylon, as previously mentioned, is a generic term and some eight to ten different grades are commonly in use covering the principal requirements. Tensile strength (at elastic limit) may range from about 6000 psi up to 11,500 psi (28,000-60,000 ultimate) and melting point from 350° F to 500° F. Water absorption may be as low as 1·5% for amino acid polymer, up to 11-12% for the softer caprolactam polymer. These characteristic figures are quoted merely to show the considerable difference possible with the normally used grades.

A number of 'loaded' nylons are also used, principally for bearing surfaces. Most commonly used fillers (or loading materials) are graphite and (to a somewhat lesser extent) molybdenum disulphide. These have the effect of improving the dimensional stability of a moulding (slightly), reducing the coefficient of friction and giving a small increase in tensile strength. Fatigue resistance and impact resistance is however, usually reduced. Again this is a characteristic of plastic materials. Improvements in one direction usually result in some loss of performance in others, In selecting an 'improved' plastic, therefore, one must also look for the disadvantages involved.

In the bearing field ptfe (polytetrafluoroethylene) has made remarkable strides and is now regularly used for impregnating sintered metal bearings. Ptfe has an extremely wide service temperature range (roughly from —100° up to 570° F) as well as an extremely low coefficient of friction. This is a cheaper form than fabricating the bearing in solid ptfe whilst still giving high load bearing and running speeds and a generally superior performance. The chemical inertness of ptfe is also remarkable, making it a first-choice material for many applications involving a corrosive ambient.

A number of other plastic materials have also recently appeared on a commercial scale showing decided advantages over nylon for bearings and similar load-carrying applications—notably polyacetal. This is a high melting point thermoplastic with exceptional dimensional stability which enables it to be used on applications where other materials of similar strength, like nylon, are unsuitable. It also has a very low coefficient of friction (approximately 0·1 when rubbing dry on steel) and a low coefficient of thermal expansion. Leading properties are summarised in Table 1.

Mechanical properties of polyacetal are generally taken as similar to nylon, although greater accuracy can

Table I.—TYPICAL PROPERTIES OF POLYACETAL

Property		Value	
Specific gravity		1·425	
Melting point		175° C	347° F
Max. service temperature intermittent		127° C	260° F
Max. service temperature continuous		105° C	220° F
Min. service temperature		not specified	
Coeff. Linear expansion		$4 \cdot 5 \times 10^{-5}$ per °F	
Thermal conductivity Btu/hr/sq ft/°F in.		1·6	
Water absorption		0·12%	
Tensile strength	lb/in²		
(D638)	at 68° F	14 700	
	73° F	10 000	
	158° F	7 500	
Compressive strength	lb/in²		
(D695)	at 1% deformation	5,200	
	at 10% deformation	18 000	
Shear strength (D732)	lb/in.²	9 500	
Rockwell Hardness		M94	R120

Tab'e II.—TYPICAL PROPERTIES OF POLYPROPYLENE

Property		Value
Specific gravity		0·905
Melting point		160–165° C 320–329° F
Max. service temperature		approx. 120° C approx. 250° F
Min. service temperature		0° C 32° F
Coeff. linear expansion		$1 \cdot 8 — 2 \cdot 1 \times 10^{-4}$ per °C.
Thermal conductivity K cal/mhr. °C		0·19
Water absorption		Nil
Tensile strength (DIN 53445)	lb/in.²	4300—5 000
Compressive strength (DIN 53454)	lb/in.²	15 600
Tear strength (DIN 53445)	lb/in.²	5700—6 400
Brinell hardness		630—660
Modulus of elasticity	lb/in.²	$17 \cdot 1 — 21 \cdot 3 \times 10^4$

Table III.—TYPICAL PROPERTIES OF POLYCARBONATE

Property		Value
Specific gravity		1·20
Melting point		220–230° C 428–446 °F
Max. service temperature		135° C 275° F
Min. service temperature		—100 °C —148° F
Coeff. linear expansion		60×10^{-6} per °C
Thermal conductivity K cal/m hr. °C		0·17
Water absorption		0·4% max.
Tensile strength (DIN 53445)	lb/in.²	8 800—9 500
Compressive strength (DIN 53454)	lb/in.²	11 500—12 000
Flexural strength (DIN 54452)	lb/in.²	15 500—17 010
Elastic modulus	lb/in.²	$31 \cdot 5 — 35 \cdot 0 \times 10^4$

be achieved both by machining or moulding because of the greater dimensional stability of the material. Compressive stress can also be uprated, compared with nylon. It is becoming increasingly used for bearings, gears, etc., as an alternative to nylon, or for components where nylon has proved unsuitable because of inadequate dimensional stability.

Polypropylene is another alternative to nylon, with greater stiffness and rigidity and similar hardness and excellent resistance to abrasion and wear. It also has the characteristics of being virtually impervious to water and will resist attack by certain chemicals which do affect nylon (e.g. hydrochloric and sulphuric acid solutions). Being a petroleum derivative, however, it is attacked by petroleum solvents such as petrol and benzol. Leading properties are summarised in Table II.

A third new plastic of considerable interest is polycarbonate, again with virtually negligible water absorption and good dimensional stability. Unlike polypropylene which does not have good low temperature properties (it is not recommended for use below freezing point), polycarbonate retains excellent mechanical properties down to −150° F. It is normally processed in the form of injection mouldings or extrusions (rod or sheet), but can be machined. In the latter case, however, considerable stresses are set up in the material, calling for stress-relief treatment. Typically, this consists of heating in an oil bath at a temperature of approximately 250° F for a time determined by the thickness of the component (typically one hour for every $\frac{1}{16}$ in.). Leading properties are summarised in Table III.

Dust Measuring Equipment

Dust measuring equipment for power stations and processes made by the Electronic Apparatus Division of Associated Electrical Industries Limited, Crown House, Aldwych, London WC2, responds to dust area but overcomes the disadvantage of optical methods whereby flue gas velocity affects the indication, by automatically taking into account the product of particle number, velocity and area. This is achieved by providing the continuously flowing sample of gas with a corona environment, where all solid particles become electrically charged; the charge is proportional to the particle surface area. The charge on the particles collected thereby forms a current potential proportional to particle number, area, and flow velocity, which after amplification, is used either to indicate or to record the level of pollution. A warning can be given should the pollution rate rise above some pre-determined level.

When installed in a duct of a chimney, the inlet of this sampling equipment is placed so that average velocity conditions are presented to it. The outlet, in the form of a conical diffuser to overcome the impedance of the equipment to the flow of the gas being sampled, is also placed in the main duct stream. To prevent condensation of moisture in the sampling equipment, the temperature of working parts is kept above dew point. Build-up of dust in the equipment is prevented by automatically purging with air for a few seconds once every twenty minutes. The equipment, will respond to particle diameter ranging down to 0·01 microns, and can monitor flue gases leaving dust-arresting plant of large boilers with burdens of about 0·04 grains per cubic foot rising to 2 grains per cubic foot during soot blowing. A recorder chart is available, showing 24 hr. running on a continuous load station.

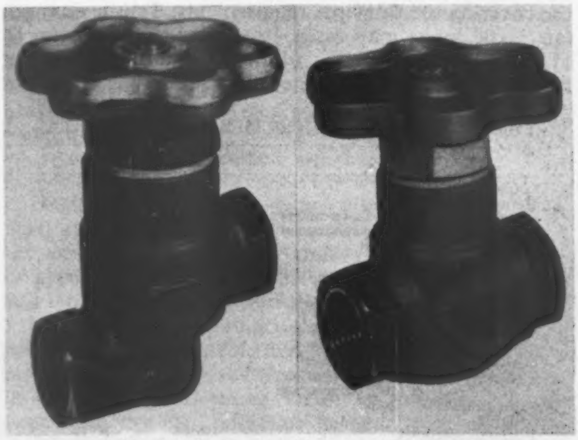
Stillage Castors

Castors suitable for fitting to stillages and so making them portable are being supplied by Flexello Castors and Wheels Limited, Slough, Bucks. Constructed of heavy gauge pressed steel with cast iron wheels and nickel chrome steel ball bearing swivels, they may easily be bolted or welded to the underside of the stillage, giving sufficient clearance below the legs without interfering with normal handling and stacking operations. The castors should be secured to a flat base, and all that is normally necessary is the addition of two sections of angle parallel with the side members of the stillage base frame. Apart from providing a firm fixture, the angle sections protect the castors from the forks of the lifting truck.

The Flexello stillage castor

Gunmetal Stop Valves

Type 60 valves manufactured by Simplifix Couplings Limited, Hargrave Road, Maidenhead, are available in $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in., and 1 in. B.S.P. (female) sizes. All are manufactured in gunmetal with spindles made from manganese bronze having a fine thread to facilitate opening and closing. The spindle seal is inside the thread and so the medium in the valve does not come into contact with the thread. The valve tip is of nylon. The valves are designed for use in either pneumatic or hydraulic circuits or with non-corrosive gases. The maximum working pressure ranges are: hydraulic, 1000 psi—250 psi; gases, 200 psi—100 psi.



Simplifix Type 60 gunmetal valve. Left, offset; right, in-line

Viscoidal Damping

In considering the motion of bodies attached to springs or other elastic media and under the action of damping, it is usual to assume that the damping resistance is proportional to the velocity (viscous damping) and on this basis the time taken to come to rest is theoretically infinite on exponential decay. In practice, however, the resistance may be equal to or approach the value v^2 used in hydraulics, which, it will be shown, gives a finite value for the time taken. In this case it appears to be impossible to solve the general equation exactly but an investigation has shown that a closely approximate solution can be obtained. The article is based on a paper given by the author at McGill University, Montreal

By W. H. SHEPPARD, B.Sc.(Eng.)

CONSIDERING viscous damping in the first instance a mass-less system will be dealt with as represented diagrammatically in Fig. 1. The following formulae are derived in standard works on mechanics and are easily checked by differentiating.

$$\begin{aligned}
\text{Let } R &= kv \\
\text{then } k.d\delta/dt &= S\delta \\
\textit{soln. } \delta &= d\epsilon^{-(S/k)t} \\
v &= -(Sd/k)\epsilon^{-(S/k)t} \\
f &= d(S/k)^2\epsilon^{-(S/k)t} = (S/k)^2\delta
\end{aligned}$$

$$\begin{aligned}
\text{where } \delta &= \text{displacement} \\
v &= \text{velocity} \\
f &= \text{acceleration} \\
k &= \text{viscocity constant} \\
S &= \text{stiffness} \\
R &= \text{resistance} \\
V &= \text{initial velocity} \\
\tau &= \text{time constant} = \text{time to reach zero at initial velocity.}
\end{aligned}$$

This is always exponential decay motion and not vibratory. The velocity-time curve is thus indicated by $n = 1$ in the top line Graph Series I.

Now consider a mass-included system as indicated in Fig. 2. In this case (also viscous damping)

$$mf + kv + F = O$$

$$d^2\delta/dt^2 + \alpha.d\delta/dt + \beta\delta = O \text{ where } \alpha = k/m \text{ and } \beta = S/m.$$

The fundamental solution is when $\delta = O$ at $t = O$ but for the present purposes the solution corresponding to free release will be considered i.e. $d\delta/dt = O$ at $t = O$

There are three cases

I. Underdamping (vibration)

$$\delta = d\epsilon^{-at}(\cos bt + (a/b)\sin bt)$$

$$\text{where } a = \tfrac{1}{2}\alpha \text{ and } b = \sqrt{\beta^2 - (\tfrac{1}{2}\alpha)^2}$$

II. Critical damping

$$\delta = d\epsilon^{-at}(at + 1)$$

$$\text{where } a = \tfrac{1}{2}\alpha \text{ and } \beta = (\tfrac{1}{2}\alpha)^2$$

$$\begin{aligned}
\text{then } v &= da^2t\epsilon^{-at} \\
t = O \quad f &= da^2 \\
f = O \quad t &= 1/a \quad v = -da/\epsilon
\end{aligned}$$

III. Overdamping

$$\delta = d\epsilon^{-at}(\cosh bt + (a/b)\sinh bt)$$

$$\text{where } a = \tfrac{1}{2}\alpha \text{ and } b^2 = \sqrt{(\tfrac{1}{2}\alpha^2) - \beta}$$

Comparing these cases it will be observed that I and III are of a similar nature, interchanging circular and hyperbolic functions, but the critical case II has a linear factor $(at + 1)$ and in this respect it will be realised that the constant 1 is intermediate between cos bt and cosh bt whereas the coefficient (at) is intermediate between (a/b) sin bt and (a/b) sinh bt. The effect of this on the exponential factor is to make the beginning horizontal for free release and it was thought that the same principle might be used to determine a solution for the general case.

To this end the equation for the mass-less system was first considered with $R = kv^2$ (*viscic* damping) and found to be capable of relatively simple solution by inverse integration as follows:

Viscic damping, $n = 2$

$$\begin{aligned}
R &= k(-v)^2 \qquad F = Ss \\
k(-v)^2 &= S\delta \\
k(-d\delta/dt)^2 &= S\delta \\
-d\delta/at &= (S\delta/k)^{1/2} \\
dt/d\delta &= -(k/S)^{1/2}\delta^{-1/2} \\
t &= -2(k/S)^{1/2}[\delta^{1/2} + C] \\
t = O,\ \delta = d,\ C &= -d^{-1/2} \\
t &= -2(k/S)^{1/2}[\delta^{1/2} - d^{1/2}] \\
\delta &= [d^{1/2} - \tfrac{1}{2}(S/k)^{1/2}t]^2 \\
S = O,\ T &= 2(dk/S)^{1/2} \\
v &= -2[d^{1/2} - \tfrac{1}{2}(S/k)^{1/2}t]\tfrac{1}{2}.\ (S/k)^{1/2} \\
\therefore \quad v &= -(S/k)^{1/2}[d^{1/2} - \tfrac{1}{2}(S/k)^{1/2}t] \text{ or } -(S\delta/k)^{1/2} \\
t = O \quad V &= (Sd/k)^{1/2} \quad \tau = (dk/S)^{1/2} = \tfrac{1}{2}T \\
f &= \tfrac{1}{2}(S/k)
\end{aligned}$$

$\therefore$ motion is uniformly deccelerated.

The graph for δ against t is a parabola with the t axis tangential thereto as shown on Graph Series I. In considering the possibility of a general solution (viscoidal damping) it was realized that at this point a finite value of $d^2\delta/dt^2$ exists and therefore no amount of adjustment by a linear factor for a mass-included system would fit in the general equation:

$$mf + kv^n + F = O$$

since at this point v and $F = O$. In reconsidering the

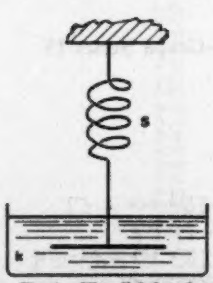


Fig. 1.—Viscodial damping

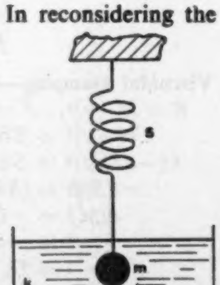
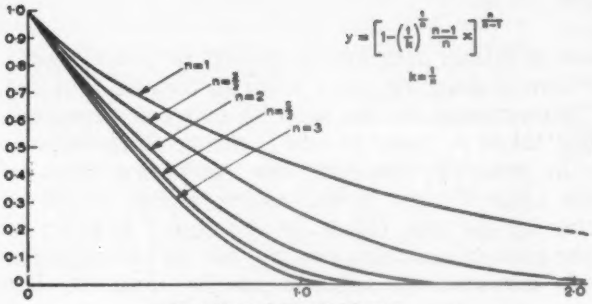
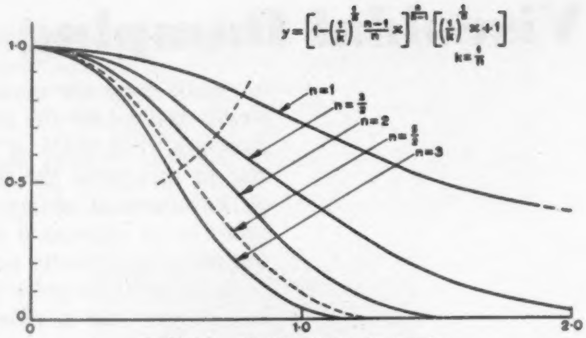


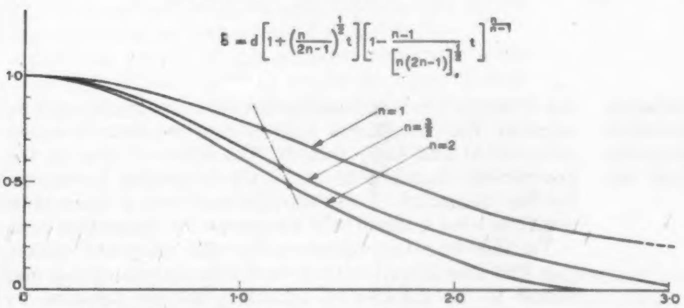
Fig. 2.—Viscoidal mass damping



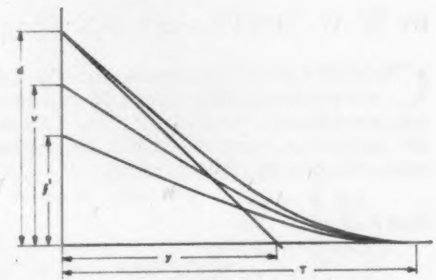
Graph Series. I. Viscoidal damping



Graph Series. II.—Viscoidal inertia damping



Graph Series. III.—Viscoidal inertia damping curves (critical)



Graph Series. IV.—Viscoidal damping. δ,v,f, curves

matter, however, it was realized that other parabolas have zero or infinite values at this point and the calculation was repeated for a series of values of n and plotted. (In later revision the value for $n = 3/2$ was calculated and then the general case which was used for the other values).

Viscoidal Damping, $n = 3/2$

$$R = k(-v)^{3/2} \qquad F = S\delta$$
$$k(-v)^{3/2} = S\delta$$
$$k(-d\delta/dt)^{3/2} = S\delta$$
$$-d\delta/dt = (S\delta/k)^{2/3}$$
$$dt/d\delta = -(k/S)^{2/3}\delta^{-2/3}$$
$$t = -3(k/S)^{2/3}[\delta^{1/3} + C]$$
$$t = O,\ \delta = d,\ C = -d^{1/3}$$
$$t = -3(k/S)^{2/3}[\delta^{1/3} - d^{1/3}]$$
$$\delta^{1/3} = d^{1/3} - \tfrac{1}{3}(S/k)^{2/3}t$$
$$\delta = [d^{1/3} - \tfrac{1}{3}(S/k)^{2/3}t]^3 \text{ or } P^3$$
$$\delta = O,\ T = 3d^{1/3}.\ (k/S)^{2/3}$$
$$v = 3p^2 \times -\tfrac{1}{3}(S/k)^{2/3}$$
$$v = -(S/k)^{2/3}P^2 \text{ or } (S\delta/k)^{2/3}$$
$$t = O,\ V = (Sd/k)^{2/3}.\tau.d^{1/3}(k/S)^{2/3}$$
$$f = (S/k)^{2/3}2p1/3(S/k)^{2/3}$$
$$\therefore \quad f = 2/3P(S/k)^{4/3} \text{ or } \tfrac{2}{3}(S/k)S^{1/3}$$
$$f = O,\ \delta = O$$

Viscoidal Damping—General Case—Graph Series IV

$$R = k(-v)^n, \quad F = S\delta$$
$$k(-v)^n = S\delta$$
$$k(-d\delta/dt)^n = S\delta$$
$$-d\delta/dt = (S\delta/k)^{1/n}$$
$$dt/d\delta = -(k/S)^{1/n}\delta^{-1/n}$$
$$t = -n/(n-1)(k/S)^{1/n}[\delta^{(n-1)/n} + C]$$
$$t = O,\ \delta = d,\ C = -d^{(n-1)/n}$$
$$t = -n/(n-1)(k/S)^{1/n}[\delta^{(n-1)/n} - d^{(n-1)/n}]$$
$$S^{(n-1)/n} = d^{(n-1)/n} - [(n-1)/n](S/k)^{1/n}t$$
$$S = [d^{(n-1)/n} - [(n-1)/n](S/k)t]^{n/(n-1)} \text{ or } p^{n/(n-1)}$$
$$S = O,\ T = n/(n-1)d^{(n-1)/n}(k/S)^{1/n}$$
$$v = -n/(n-1)p^{1/(n-1)}(n-1)/n(S/k)^{1/n}$$
$$v = -(S/k)^{1/n}p^{1/(n-1)} \text{ or } -(S\delta/k)^{1/n}$$
$$t = O,\ V = (Sd/k)^{1/n}$$
$$\tau = (k/S)^{1/n}d^{(n-1)/n} = T(n-1)/n$$
$$f = (S/k)^{1/n}\,1/(n-1)\,p^{(2-n)/(n-1)}\,[(n-1)/n]\,(S/k)^{1/n}$$
$$f = (1/n)(S/k)^{2/n}p^{(2-n)/(n-1)} \text{ or } (1/n)(S/k)^{2/n}\delta^{(2-n)/n}$$
$$t = O,\ f^1 = (1/n)(S/k)^{2/n}d^{(2-n)/n}$$
$$t = T, \quad n < 2,\ f^1 = O$$
$$n = 2,\ f^1 - \tfrac{1}{2}S/k$$
$$n > 2,\ f^1 = \infty$$

This checks for $n = 3/2$ and $n = 2$.

It will be observed that $f = O$ is only obtained at $\delta = O$ when $n = 1-2$ *exclusively* and this applies also to mass-included cases following. To obtain results comparable with the exponential function $n = 1$, k was given the value $1/n$ by analogy with the force on a plate by a fluid $= \frac{1}{2}$ mv,^{2} considering loss of energy as against loss of momentum. These graphs are shown in Graph Series I.

A linear factor was then introduced into the calculation for each graph to make the initial slope of each equal to zero as indicated in Graph Series II. This gave promising results but the initial acceleration for each was fixed, and different for each graph. The problem was therefore completely reconsidered using the general value for the mass-less condition (including a parameter p to simplify the exposition) and $(At+B)$ as the general linear factor. Special or boundary conditions were then considered and the equations for δ, v, and f evaluated as follows.

To be continued.

Wind Pressure on Plane Surfaces

Calculation of wind pressure on plane surfaces normal to an airstream can be reduced to a simple formula, introducing an empirical drag coefficient. The latter is variable with the shape of the flat plate area and this variation can be expressed in terms of the ratio of the sides. The same treatment holds generally true for circular and elliptical flat plates normal to the wind

BASICALLY, wind pressure is an aerodynamic drag force which can be expressed mathematically in the form

Drag or wind pressure $= \frac{1}{2} C_d \rho A.V^2$

where C_d = drag coefficient

A = area of plane surface normal to the wind direction.

ρ = mass density of air

V = wind velocity

The drag coefficient is determined empirically and is not necessarily constant. It can vary with the geometric shape of the plane area and also with size, the latter being due to what is usually called scale effect. This merely implies that for aerodynamic similarity the product of wind velocity and a typical linear dimension should be constant. Its significance is that model tests are not necessarily a valid method of arriving at a drag coefficient for a particular shape unless conducted under aerodynamically similar conditions or corrected for scale effect—neither of which may be practicable.

Experimental determination of wind pressure effects was conducted long before the science of aerodynamics was established, particularly in connexion with the evaluation of wind pressure on buildings. These data, which formed the basis for strength requirements to resist wind pressure, were invariably obtained by direct experiment and are still employed with very little alteration. The main difference is that there is a greater appreciation of the effect of *distribution* of wind pressure over buildings, and in particular the presence of a pressure reduction on the leeward side which may have an appreciable effect on loading. A detailed analysis of the aerodynamic problems arising becomes increasingly important the larger the building and the more critical its design—e.g. in the design of bridges. This, in fact, has become a highly specialized subject.

In the more general engineering world problems concerning wind pressure on exposed plane surfaces frequently arise, with often very little data to go on. The generalized 'design wind pressure' figures for building—e.g. 30 lb/sq ft maximum—are unlikely to yield consistent results. The apparently simple job of calculating a suitable size of concrete base to support, say, a square vertical board exposed to winds, becomes very much a matter of trial and error, with the emphasis on the 'error'. Either the base is made excessively large and heavy, so that the whole thing becomes difficult to shift, or too small so that it topples over in a high wind.

In its most elementary form the wind pressure formula can be reduced to the form

Wind pressure $= KV^2$

where K is a constant appropriate to the shape of the plane surface considered.

Typical values of K for large, vertical surfaces normal to the wind are 0·003 to 0·0035, where V is in miles per hour, leading to

Wind pressure $= 0{\cdot}0032\ V^2$ lb/sq ft at V mph or wind $= 0{\cdot}00148\ V^2$ lb/sq ft at V ft/sec.

Table I lists this relationship for a range of wind velocities.

Whilst these figures may show a mean value representative of the wind pressure on large surfaces, local pressures may be higher (or lower) and maximum pressure values may exceed the calculated (or tabulated) figures where the wind is variable or the normal velocity is influenced by adjacent objects upstream. Further, such a simple formula does not take into account the difference in vortex generation (or aerodynamic drag) known to exist behind different geometric forms.

For accurate analysis, therefore—even with simple plane surfaces normal to the wind—it is necessary to introduce a form factor which takes into account this variation in drag coefficient. The only satisfactory way of finding the form factor is experimentally and, unfortunately, much of the data accumulated on this subject presents wide variations in results.

Comparing the original empirical formula with the basic aerodynamic formula for flat plate drag, and expressing both as drag per unit area, we find that the expression

$$P\ (\text{lb/sq ft}) = 0{\cdot}0032\ V^2$$

is equivalent to

P (lb/sq ft) $= C_d \times 0{\cdot}0019$ slugs/cu ft $\times V^2$ (mph) when the drag coefficient, $C_d = 1{\cdot}25$.

Table I.—WIND PRESSURE FIGURES

Wind Velocity	Condition	Mean Wind Pressure
mph		lb/sq. ft
10	Gentle Wind	0·32
20	Light Breeze	1·28
30	Moderate Wind	2·88
40	High Wind	5·12
50	Gale	8·00
60	Storm	11·52
70	Heavy Storm	15·68
80	Violent Storm	20·48
90	Hurricane	25·92
100	—	32·0

Table II.—DRAG COEFFICIENTS FOR FLAT PLATE

Ratio $\frac{\text{Smaller Side}}{\text{Larger Side}}$	C_d
0·01	1·86
0·02	1·72
0·03	1·63
0·04	1·55
0·05	1·49
0·06	1·44
0·07	1·40
0·08	1·36
0·09	1·33
0·10	1·30
0·20	1·185
0·30	1·181
0·40	1·179
0·50	1·177
0·60	1·176
0·70	1·174
0·80	1·172
0·90	1·171
Square Plate	1·170

Note: Values for intermediate ratios may be interpolated or read from Fig. 1.

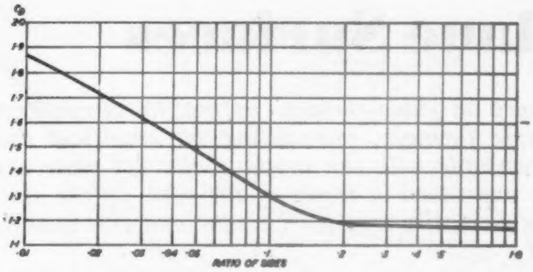


Fig. 1. Variation of drag coefficient with ratio of sides of flat plate

This is the same as rewriting the basic aerodynamic formula in the form—

$$P\ (\text{lb/sq ft}) = 0{\cdot}00256\ C_d\ V^2$$

where V is in mph

$$P\ (\text{lb/sq ft}) = 0{\cdot}001185\ C_d\ V^2$$

where V is in ft/sec.

It is accepted in this case that the drag coefficient C_d is variable with form, rather than adopting the constant figure applicable to the empirical formula. Strictly speaking, C_d could be expressed as a constant drag coefficient multiplied by a form factor, i.e.

$$C_d = C_{dc} \times F_c$$

where C_{dc} is the constant value of drag coefficient F_c is the form factor appropriate to the geometry of the flat plate.

It is more convenient, however, to determine C_d as a single factor for substitution in the aerodynamic formula.

Values for C_d which show generally good agreement with practice for moderate flat plate areas (e.g. from 1 to 100 sq ft in area) are summarized in Table II. The variation in C_d with height/length ratio, or more specifically the ratio of the length of the sides, is more clearly indicated by the graph Fig. I. It will be seen that a square shape represents a minimum drag coefficient for a plane surface and that drag increases as the height is reduced, relative to the length, for the same surface area.

Given the dimensions of the flat plate area, the corresponding drag coefficient can be found from Table II and substituted in the above formula. It will be appreciated that the attitude of a rectangular shape in the vertical plane does not affect the ratio of the sides, in a uniform airstream. In other words, it is the ratio of the shorter to the longer side which counts in determining the drag coefficient, irrespective of whether the rectangle is horizontal or vertical, or in any intermediate attitude in the same plane normal to the airstream. Example—Calculate the wind pressure of a plane surface normal to a 30 mph airstream, the length of the sides of the rectangular surface being 6 ft and 3 ft.

Here the ratio of the sides is $3/6 = 0{\cdot}5$.

The drag coefficient is therefore 1·77 (Table II)

Substituting in the aerodynamic formula

$$P\ (\text{lb/sq ft}) = 0{\cdot}00256 \times 1{\cdot}77 \times 30^2 = 2{\cdot}71\ \text{lb/sq ft.}$$

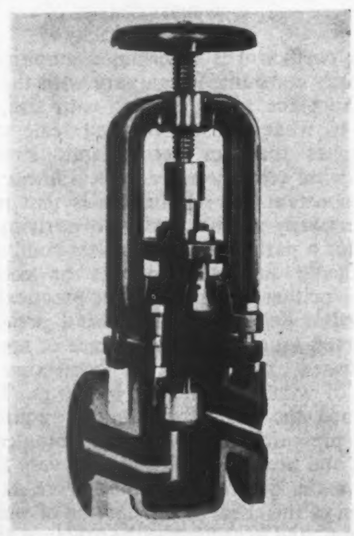
The area of the plane surface is $6 \times 3 = 18$ sq ft.

Therefore total wind pressure $= 18 \times 2{\cdot}71 = 49$ lb approx.

For non-rectangular shapes the drag coefficient will be further modified. The drag coefficient of a circular plate, however, is very similar to that of a square plate and for all practical purposes can be taken as identical. The same variation in drag coefficient as in Table II (or Fig. 1) can then be anticipated for elliptic shapes, substituting the ratio of the major and minor diameters for the ratio of the sides. This again appears to give results consistent with practice. It will be obvious, however, that although the drag coefficients of, say, a 3:1 rectangular flat plate and a 3:1 ellipitical flat plate are virtually identical, the total wind pressure on the two surfaces (at any given wind velocity) will be appreciably different because of the difference in surface areas.

Protective Valve Lining

Valves lined with Bascodur, an anti-corrosive protective lining are now available in Britain through I. V. Pressure Controllers Limited, 683 London Road, Isleworth, Middlesex, who have the sole rights. Composed of a carbonaceous base agglomerated by means of a thermosetting resin it is highly resistant to corrosion caused by chemical agents, acids, alkalis and solvents and is capable of resisting elevated temperatures and performs excellently under rigorous hardness, shock and flexural tests. It is also usable in the presence of gamma radiation up to a



Valve in cross-section showing Bascodur protective lining

dosage of at least 10^8 rontgen, subject to modifications which may occur if very strong chemical factors are added to the action of the radiation.

Bascodur lined plug valves, globe valves and angle valves are all suitable for pressures of 150 psi and temperatures up to 300° F. Globe valves are used where flow regulation does not permit the use of cocks, or when severe service conditions require tight sealing. Angle valves are similar in design and construction to globe valves, but are used for tank mounting where the space available cannot accommodate normal valves or plug valves. Bascodur low-pressure gate valves are designed for large flow capacities with low pressure loss. Standard gate valves are also suitable for use in low pressure circuits.

Precision Locking Nuts

A range of precision forged self-locking nuts has been introduced by Simmonds Aerocessories Limited, Treforest, Glamorgan. Now in volume manufacture and available through the normal supply channels, the immediate range covers the Nyloc self-locking nuts in all the sizes, in both full and thin thicknesses, from ¼ in. to ½ in. diameter in Unified Fine thread.

Developments in Magnesium Alloys

While magnesium and its alloys are well-established as engineering materials possessing important properties, over the last five or six years problems have presented themselves demanding solution. In consequence, various experimental studies have been carried out, all designed to increase knowledge of this range of materials. Some of these are summarized

STRESS corrosion in metals almost always produces cracks, and this is true of the magnesium-base alloys; but how this form of corrosion produces the cracks is not completely understood. In consequence, an investigation was begun to examine the stress-corrosion behaviour of an extruded magnesium alloy to develop a mechanism of stress corrosion. The alloy chosen was one containing 6% aluminium, 1% zinc and 0·2% manganese, which is susceptible to stress corrosion. The results show that the influence of the mechanical factors in the transgranular failure of the alloy was greater than has been generally recognized. The crack tends to follow the basal plane, so that this plane appears to be significant as regards deformation and fracture, as well as the potential paths of corrosion. The effect of electrochemical factors was verified, and a reasonable explanation given for the transition from an intragranular path of fracture to a transgranular path, depending on the type of treatment used. A protective current has been shown to control the onset or course of stress corrosion, which can, it is believed, be controlled by impressing a sufficiently large voltage on the system. The substitution of dry benzene for an electrolyte stops corrosion when in progress.

Electrochemical reactions, in short, play a primary and continuous part in the stress-corrosion of the alloy studied. Stress does not cause purely mechanical failure, its role being secondary in that it contributes to the electrochemical reaction by tearing films. Plastic deformation could take place along certain preferred crystallographic planes for large-grained material and at grain boundaries for small grained material.

The ultimate objective of all investigations of the simple stressing of single metallic crystals has been the complete rationalization of the plastic behaviour of polycrystalline aggregates. High purity magnesium was chosen for a recent research designed to make a preliminary study. Polycrystalline magnesium was observed to slip exclusively by the mechanism at room temperature. Twinning occurred exclusively along certain planes. Low angle kink boundaries issuing from the spurs of mechanical twins agreed with the hypothesis that they consist of a series of edge dislocations on other planes. Grain boundary shearing was observed at room temperature. Non-crystallographically orientated low angle boundaries were produced during deformation of polycrystalline aggregates of magnesium. Rupturing occurred on a number of high order crystallographic planes as well as along the grain boundaries. The occurrence of non-basal slip has since been observed on many occasions at atmospheric temperatures.

Arising out of these and earlier studies, an attempt was made to uncover the various complex mechanisms of deformation that polycrystalline aggregates of metals might undertake, again with high purity magnesium as the metal chosen for investigation. The studies were extended to subatmospheric temperatures down to the boiling point of liquid nitrogen, 78° K. Basal slip was found to be the main mechanism of deformation, with duplex slip becoming more predominant as the temperature was increased. Grain boundary shearing was rare at the low temperature compared with that observed at room temperature. The appearance of twins and small angle boundaries was unchanged by lowering test temperature. The fracture at low temperature was mainly intergranular with some complex transcrystalline modes.

Alloys of magnesium often include lithium and aluminium. To throw light on the source of mechanical property difficulties in these alloys, and to resolve the inconsistencies in this system, phase relations in the neighbourhood of the alloy have been undertaken. The existance of a ternary phase was verified, but it was not an equilibrium phase at any of the temperatures studied.

Another group of magnesium-base alloys contains lithium and zinc. These alloys are age hardening, and precipitation occurs rapidly on quenching, though maximum properties are apparently not attained until after several days of ageing at room temperature. It was decided to establish the equilibrium phase relationships more definitely by using a wider composition range than former studies, at several temperatures. A ternary phase of wide miscibility was identified, but was not an equilibrium phase at any of the temperatures studied.

Magnesium is of commercial importance in the manufacture of nodular iron. Magnesium is difficult to add to molten iron because of its high vapour pressure at the molten iron temperature, and because at high temperatures it reacts with explosive violence with the oxygen of the air. It is therefore added in dilute alloys with other metals. This increases the cost, and some of the diluting elements are prejudicial. Also, magnesium forms hard spots in castings, which may have to be annealed for machining. Attempts to find a way of making nodular iron without these drawbacks was attempted, and proved successful. Commercial cupola heats using mixtures of sodium and magnesium chlorides with calcium silicide as reducing agent provide, it is believed, a safer and better process for producing readily machinable and ductile nodular iron without annealing and without introducing other elements with the nodulizing element.

The magnesium-zinc system has been studied and it has become apparent that the sluggishness of many reactions of these alloys is remarkable. It is probably because of this that there has been so great a divergence

of opinion as to the constitution of these alloys. Clear microscopic and x-ray diffraction techniques unambiguously demonstate the existence of particular phases which were the subject of doubt.

The deformation and fracture of alpha solid solutions of lithium in magnesium have also been studied. Interesting results were obtained concerning the deformation mechanisms operative in solid solutions of lithium in magnesium. These increase the low temperature ductility of magnesium. Large amounts of lithium in magnesium solid solutions decrease the rate of strain hardening in the alloy to such an extent that the higher lithium content alloys have lower stress strain curves than pure magnesium. While pure magnesium fails in a brittle manner between 78° and 298° K, with fracture strengths independent of temperature, the high lithium content, magnesium alloys fail in a ductile manner at all temperatures, showing localized necking and a marked effect of temperature on fracture strength. The increase of ductility and decrease of strain hardening rate in the alloys seems to be associated with prismatic slip in addition to basal slip. The addition of lithium to magnesium decreases the c/a ratio in the hexagonal lattice, and this decrease seems to be associated with the introduction of the prismatic slip system.

Ceramic materials have been hampered in their application by a serious lack of ductility. Attempts have therefore been made to make a number of refractory materials that would be ductile at room temperature. So far, the most encouraging results have been had with magnesium oxide. Single crystals of this material have been bent through substantial angles without fracture at room temperature. Surface elongations up to 20% have been obtained in the bend tests. It now appears that there is a good chance of developing a number of ductile ceramics. during the next few years.

The constitution of the magnesium-rich portions of two alloy systems is important to the development of a group of magnesium alloys which are at present arousing much interest. These are the magnesium thorium alloys and the magnesium-thorium-zirconium alloys.

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Recent work on magnesium crystals stressed in tension parallel to the basal plane has shown that large shears, in some instances as great as 1000%, may occur inside small thin twins. It has also been noted that if this shear deformation is carried far enough, the metal inside the twin ruptures, producing what is known as a 'parting' or fracture which follows the habit plane of the twin.

In pure magnesium, stress conditions capable of producing twins are unable to nucleate them in sufficient numbers to permit general lattice deformation. It is suggested that the propensity of a magnesium alloy to twin and form bands is the determining factor whether the alloy can undergo unlimited cold-rolling.

Certain magnesium alloys exhibit unlimited cold rollability. The deformation mechanism accounting for their unusual property variations has been investigated. Cold-rolling of these alloys causes discrete volumes of the metal to become reorientated to a position in which the operation of basal slip within them is highly favourable. These bands act as 'soft' regions during a tensile test, and because their numbers increase as reductions increase, the measured tensile strength decreases. Preliminary work indicates that the mechanism responsible for the formation of these bands is double twinning. The bands harden during ageing, possibly because of polygonization followed by solute atom pinning of dislocation walls.

The welding of magnesium alloys presents problems, most of which concern the basic properties of the pure metal. Susceptibility to oxidation and a high coefficient of thermal expansion are well-known examples. The weld-cracking properties of binary magnesium alloys have been found to be related to alloy constitution, and particularly to the solidification range. This suggests that weld-cracking is akin to hot tearing, and no satisfactory explanation can be given for observations that a biaxial stress system is necessary for cracking. The cracking tendencies of the tenary magnesium alloys vary in a manner suggesting that the solidification range is also of predominant importance here.

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between the several parties concerned, but of course, the insured had to submit to an appropriate amendment of the quoted premium. They may perhaps have found some small solace in the fact that for several preceding years they had enjoyed a much cheaper rate and the company had not had any breakdown claims during the period they were on risk. This machine belonged to the 'nineties period, and had an interesting and useful feature. It was of massive design, open over-type drum, smooth core armature, and huge two pole field magnets of soft Swedish iron. One of the magnet limbs was fitted with a hinged strap which allowed quick withdrawal of the armature in case of repair, without dismantling the machine.

Commutator end V-clamp rings vary widely in design, and have been the source of many serious breakdowns. With some types, particularly in the smaller ranges, such clamp rings made of cast iron and not uncommonly of brass, would be screw-threaded on the driving shaft or a separate sleeve. In fitting, the V-mica or micanite insulating ring was liable to get torn and so badly damaged as to reduce the laminae to almost thin-paper gauge and so rendering it liable to breakdown. Some clamp rings would be formed with a deep V-oil thrower ring which did more harm than good, since any thrown oil was liable to be deposited on the string binder invariably fitted to seal the mica edges. This string band sooner or later became oil-soaked and carbonized, causing creepage and breakdown.

Axial through-bolts holding the clamp ring to the commutator sleeve have often failed through excessive strain or short circuit due to accidental fouling with the bars inside the commutator mounting, or loose foreign matter which may have been drawn inside.

A d.c. generator of multi-polar type had just been taken over by a new company. Soon after a breakdown occurred and a surveyor attended to make the usual examination. On running there was some sparking and noisy chattering of the carbon block brushes. Examination of the commutator revealed protruding inter-bar micas, and on light tapping by hammer several bars appeared to be loose. It was almost decided to tighten up the end clamp ring but on reflection it seemed unlikely that a well-seasoned commutator after several years' running should work loose without warning. Past records were looked up, and one of the reports revealed that a previous breakdown of this machine had occurred through slackening off a section of the commutator bars. This gave a clue, and so the machine was partly dismantled and close examination made. The cast iron end clamp ring was now withdrawn and the cause of the trouble was revealed; radial cracks extended from all the bolt holes and the casting was porous and altogether a very poor job. There were definite signs of movement on the through bolt shanks, and the marks indicated that the end ring had been tightened up considerably since leaving the maker's works. Fortunately the damage to the commutator itself was not extensive, and the fitting of a new steel ring made a sound repair.

A three-phase squirrel-cage motor came to a sudden stop on normal load. The usual examination and tests were made by a surveyor, and on opening up the motor terminal box it appeared that one of the stator lead-in cables had become detached from its terminal binding post. Now, it is the usual shop practice to leave a little slack on such lead-in wires. But this particular lead seemed altogether too short, in fact it was a tight fit to its terminal, so a new and longer piece of cable was fitted. The machine otherwise seemed undamaged and so was switched on load and ran satisfactorily. Since production conditions did not require this motor until later, the surveyor left feeling that all was now in order. The following day, however, he received an urgent request to attend as the motor had again failed. This time the fault was similar to the first except that it was phase lead No. 2 that had become detached, the lead-in cable being torn out of its sweating socket. This rather unusual happening called for close investigation. The motor being fixed in an awkward corner on wall brackets near the room roof, it was taken down. On opening out it appeared that the three stator leads had all been severely strained, Nos. 1 and 2 already had failed, and No. 3 lead was on the point of being pulled out of its terminal socket. Further examination made exact diagnosis fairly easy, and, strange to relate, the cause of the trouble was due to circumferential movement of the stator shell in the frame casing which resulted in the unnatural pull on the stator leads. The windings were not damaged, and the loose stator shell was reset and tightened by pinning this repair proving satisfactory.

In engineering insurance surveys extraneous risks such as time and consequential loss, and flooding will sometimes form an important part of a surveyor's work, through the incidence of a breakdown of an insured machine. At a cotton mill, where the plant included a large turbo-alternator and main switchboard, inspection was usually made during the factory dinner-hour stoppage. The surveyor had completed a period inspection and everything appeared to be in order. It was the usual procedure to await the restarting of the plant, but on this particular occasion the surveyor left earlier to attend a rush job elsewhere. Imagine his surprise on arriving at this works to find an urgent almost frantic telephone message to return at once as the turbo-alternator had apparently broken down. He hurried back and found the maker's men already there. The machine tests were satisfactory and excited to full voltage but the generator main circuit breaker would not close on the bus bars. The circuit-breaker was of conventional 3-phase oil-immersed type fitted with phase barriers. The three V-copper contact members were attached to insulated steel rods each being fitted with double lock-nuts. One of the V-contacts had come adrift and lay at the bottom of the oil tank.

On close examination of the faulty phase leg it appeared that the lock-nut had "slacked off" allowing the top contact nut to gradually work loose, and on this unlucky day the nut probably was on the last thread, and the shock on opening the circuit-breaker for testing had caused the V-contact to break away and so fall to the bottom of the tank. Fortunately there was no breakdown within the meaning of the turbo-alternator policy. The necessary repair was quickly effected and opportunity was taken to provide additional protection by the fitting of split pins to the lock-nuts on all three spindles.

A case in which the circumstances were most singular, incidentally caused a surveyor to spend quite a lot of time on extraneous matters strictly outside his normal duties. His working list contained a works plant of a number of motors, geographically situated on the outskirts of an industrial town, the site being near a river. For several years the plant had been a good risk, no breakdowns having occurred. However, a very wet summer with heavy floods was experienced, and the near-by river overflowed its banks with disastrous results. The works was flooded, several of the motors

being completely submerged. After the water had subsided the machines were inspected and several seemed to be amenable to drying-out, but others had been damaged by silt and stony matter, and would require extensive repairs.

The owners made a tentative claim, but of course, on close perusal of their breakdown policy they realized that flooding was not included on the risk. It was pointed out however, that flooding could be included as an extra at a small additional premium. After the damaged motors had been repaired and overhauled the insured decided to have the extra cover added, and so the policy was duly amended and endorsed accordingly, entered in the usual way on the surveyors' list, and all concerned seemed quite happy.

The plant continued to operate without anything untoward happening. Then one day during an ordinary period inspection the work's manager, in the course of a chat with the surveyor, mentioned that they were about to make some reorganization of their works and that would include certain economies, particularly various insurances. In their deliberations the management had reviewed the engineering policy and decided to cut out the flooding-extra. So, the necessary alterations were made to the policy. Again the works was flooded, if anything more seriously than before. It is axiomatic that there is no room for sentiment in business, but in the engineering insurance industry clients do get a decent deal, especially in "border-line" cases, and *ex gratia* allowances are not unheard of. So in due course, flooding was reinstated on the surveyor's list.

To be continued.

VOLTAGE CONTROL

Welding and Vehicle Dynamos

Concluding the discussion commenced last month of dynamo design characteristics in connexion with voltage control

By J. L. WATTS

There are, of course, occasions when it is desirable that the voltage of a dynamo should fall on increased load. This is particularly the case with an arc welding generator. The resistance of an arc depends somewhat on the length of the arc; but the arc current is not directly proportional to the voltage applied to the arc, so that it is not self-regulating.

The welding generator should, therefore, be able to supply about 60 to 70 volt to strike the arc, with fall of voltage when arc current flows, in order to avoid short circuiting the generator and to enable the arc to be controlled. About 30 to 45 volt may be required across a carbon arc, or about 25 volt for metallic arc welding.

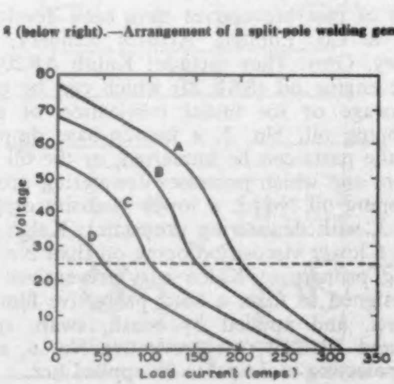
One method of obtaining the desired result is to use a differential-compound dynamo, with series field coils in magnetic opposition to the shunt field coils, giving a characteristic such as the one in curve A of Fig. 6, when the shunt regulator is set for maximum shunt field current and maximum open-circuit voltage. This setting would be suitable for metallic arc welding with about 200 amp welding current, since the terminal voltage of the generator would then fall to about 25 volt on 200 amp load. For a welding current of 150 amp the shunt regulator could be set for reduced shunt field current, giving about 55 volt on open circuit (curve B). One disadvantage of this system is that the open circuit voltage for striking the arc is low on low welding currents, as indicated in curves C and D.

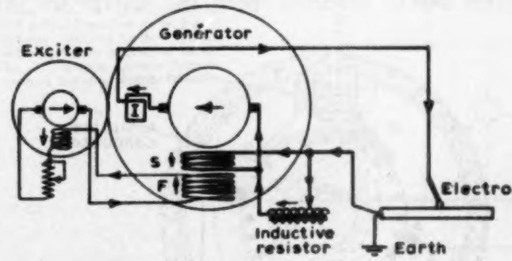
A d.c. generator having a fairly constant voltage on varying loads may be used for arc welding if the electrode is fed through a resistor designed to absorb the excess voltage after the arc has been struck, although this is uneconomical owing to considerable waste of power in the series resistor. Various resistance values are required

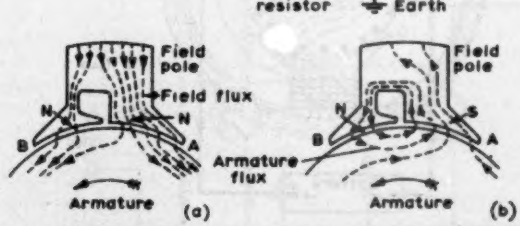
Fig. 6 (below).—Characteristics of one type of welding generator

Fig. 7 (above right).—One arrangement of a d.c. welding plant

Fig. 8 (below right).—Arrangement of a split-pole welding generator







for various values of welding current, to give a constant arc voltage. Easier welding is obtained if the resistor is wound inductively, or if a choke coil is connected in series with the resistor. Change of welding current through the choke or inductive resistor then induces voltage which tends to stabilise the arc.

Fig. 7 shows an arrangement in which a separately excited differential compound dynamo, with series field windings S and interpole coils I, is controlled by a variable inductive resistor connected as a diverter in parallel with the series field windings.

One welding generator, which has cumulative-compound windings, has specially-shaped field poles, as indicated in Fig. 8. With no load current in the armature the field magnetism created by the self-excited shunt field windings passes into the armature fairly uniformly from the pole faces, as in Fig. 8a. The voltages generated in the armature conductors passing under a given field pole then act in the same direction to give maximum generated voltage.

When load current flows after striking the arc the armature reaction creates a cross magnetism which tends to create flux which opposes the field pole flux at the entering edge A of each field pole and strengthen it at the leaving edge B. However, the combined effect of the increased current in the series field windings results in flux distribution of the form indicated in Fig. 8b, the reversed flux under part of the entering edge A reducing the generated voltage. This generator has interpoles, the volt drop on various welding currents being governed by using various resistance values between the generator and electrode.

In most cases variation of voltage output of a generator due to varying speed is undesirable and, if the prime mover drives only the generator this problem is usually dealt with by suitable governing of the prime mover. However, this method may be impracticable when the prime mover has to run at varying speeds, as in the case of a dynamo on a motor vehicle or train, and where the dynamo is only a very small part of the load on the prime mover. One method of limiting the variation of voltage of a dynamo used to charge batteries on a train is by adjusting the tension on the dynamo driving belt so that it will transmit only a limited torque. It is characteristic of accumulator cells on charge that if the applied voltage is increased the charging current will increase in a much greater proportion. Thus if the load on the train dynamo increases due to increased speed and voltage the belt slips to limit the speed, voltage and load current of the dynamo.

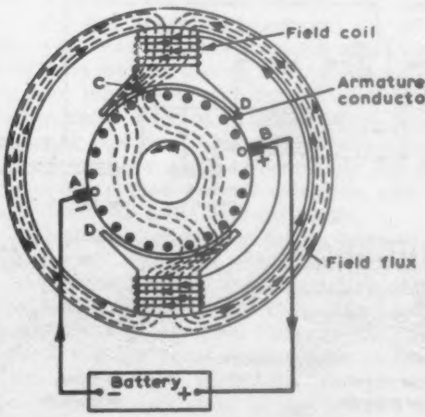


Fig. 9.—Connexions of a three-brush generator

Another method is the so-called "constant-current" system used with three-brush vehicle dynamos. This system can only be used to control the output of a loaded dynamo, as when the dynamo is charging a battery, and has no control of the voltage of an unloaded dynamo. The field winding of the three-brush dynamo is connected across one main brush B and an auxiliary brush C, as in Fig. 9. When running at high speed the charging current in the armature conductors will be in the directions indicated, a dot in a conductor circle representing current flowing towards the observer, and a cross indicating current flowing away from the observer. Armature reaction will then tend to create a magnetic flux in the armature in the general direction A—B. However, as a result of the combined magnetising forces of the armature and field coils, the resultant flux will be distorted as shown, with reduced flux under the entering edges of each pole D.

The armature conductors between the brushes B and C, to which the field coils are connected, are thus subject to reduced magnetic flux and, in this way the voltage applied to the field winding is automatically reduced at high speed to limit the dynamo voltage and charging current.

As will be seen from Fig. 10 the control becomes effective as soon as the engine speed has risen to a value at which the dynamo voltage slightly exceeds that of the battery, and the cut-out closes to connect the dynamo to the battery. It will be noted that the load current (charging current) is far from constant, in fact, but its variation is quite small in comparison with the change of dynamo speed.

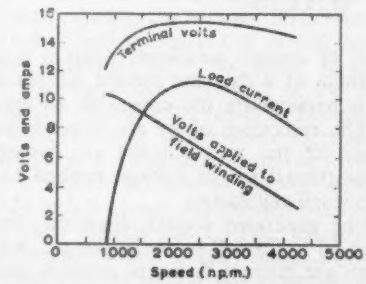


Fig. 10.—Characteristics of a three-brush vehicle generator

Rust Preventives

A number of rust preventives have been developed by K. Allan & Co. Limited, Alanzol Refinery, Bream, Nr. Lydney, Glos. They include: Kalub AR20, a rust preventive engine oil (SAE 20) which can be used for engine storage or for initial lubrication of engines; Kalco dipping oil, No. 3, a lanolin-base dipping oil, in which the parts can be immersed, or the oil may be sprayed on, and which possesses dewatering properties; Kalco dipping oil No. 2, a lower viscosity dipping oil than No. 3, with dewatering properties; Kalco dipping oil No. 1, a lower viscosity dipping oil than No. 2, with dewatering properties; Kalco rust preventives Nos. 4 and 5, designed to form a hard protective film on the metal parts, and applied by brush, swab, spray or dipping; and Alanzol rust preventive No. 6, a plastic film for protecting tool tips, to be applied hot.

Simple Electronic Bi-stable Counters

Apart from their increasing application in all fields of industry, many basic electronic circuits are simple in conception and designed for a specific mechanical action. The simple counter circuits discussed show the difference between "flip-flip" and "flip-flop" types, with many obvious applications

THE basic electronic bi-stable counter circuit offers an excellent example of an 'engineering' application of electronics and one which is now widely applied. The particular advantage offered by an electronic counter is that it responds very much more rapidly than a mechanical counter. Lacking mechanical movements of any kind—and thus inertia—it can also operate on very low input power. From the simple electronic counter has developed the vast range of complex electronic counting and measuring devices, up to digital computers.

A simple bi-stable counter circuit is merely a form of fully electronic switch, sometimes referred to as a 'flip-flip'. This is distinct from a true 'flip-flop' circuit, which is essentially a triggering device, although this description is sometimes also given, somewhat erroneously, to the bi-stable circuit. Essentially it is a bi-stable circuit with the output alternately switched on and off by alternate signal pulses applied to the input. The alternating on-off output switching thus provides a 'count' of the number of input pulses received.

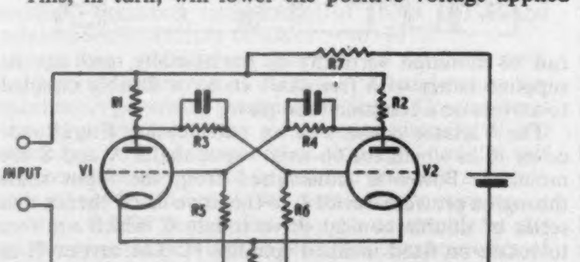
A typical basic flip-flip circuit is shown in Fig. 1, employing two triode valves. Due to any slight assymetry which will inevitably be present in the circuit one of the valves will conduct more current than the other. Assuming this is V1, there will be less voltage drop in R2 than in R1 with the result that the anode of V2 is closer to the applied voltage, causing a positive voltage to be applied to the grid of V1 through R4 (with R5 acting as a voltage divider). Hence the anode current in V1 will tend to rise still further, and with it the voltage drop in R1 will increase.

This, in turn, will lower the positive voltage applied to the grid of V2 through R3 and the voltage divider R6, the effect being to decrease the anode current through V2 still further. The cumulative effect, which builds up very rapidly, is thus for a stable condition to be reached where V1 is drawing maximum anode current, limited by the resistance R1, with V2 cut off completely (i.e. not conducting at all).

If now a pulse is applied momentarily to the input, additional current will flow through R7 with the resulting voltage drop across R7 momentarily decreasing the voltage through R1 and reducing the anode current through V1. The anode of V1 thus rises towards the B+ voltage at the same time as the bias voltage applied to the grid of V2 becomes more positive, causing V2 to draw more current. This interacts through the grid of V1 (via the voltage divider circuit R4, R5), the cumulative effect being to decrease the anode current through V1 to zero and the anode current through V2 to a maximum. In actual fact, this takes place very rapidly, the application of an input pulse switching V2 into conduction and cutting V1 off. The next impulse pulse reverses the switching again (V1 conducting, V2 cut off) and so on.

The output circuit can be taken from both or just one valve, the latter usually being more convenient—see Fig. 2. In this case the output circuit will be switched alternatively 'on' every *second* input pulse, i.e. will count in terms of the output circuit being energized, in the ratio 1:2. Various methods of recording or indicating the output signal are available—e.g. a neon indicator connected across the output would give a flashing light signal for every second input pulse.

An essentially similar flip-flip circuit is shown in Fig 3



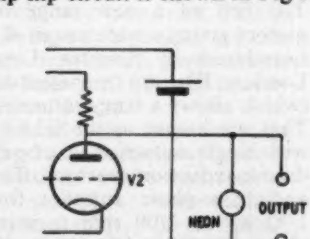
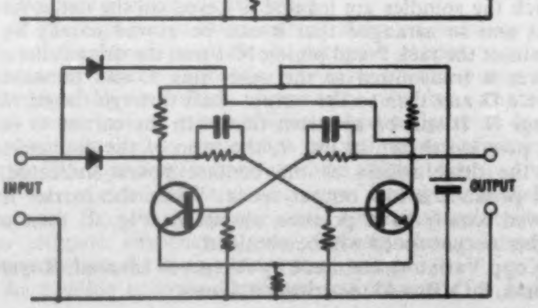
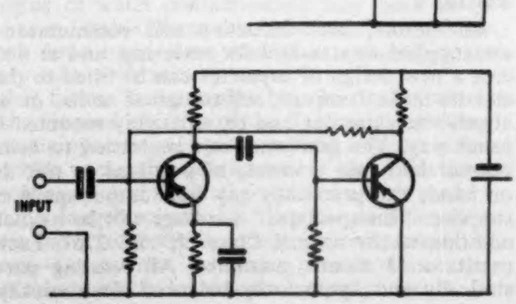


Fig. 1 (left)—Typical flip-flip circuit employing two triode valves. Fig. 2. (right)—Circuit with output from one valve. Fig. 3. (bottom left)—Flip-flip circuit with transistors instead of valves. Fig. 4. (bottom right)—Transistorized flip-flop trigger circuit





employing NPN transistors in place of valves. In this case the collector of the transistors replaces the anode, the emitter the cathode, and the base the grid. High or low-voltage transistors may be employed, according to requirements, the latter being the more common but where employed would call for an additional transistor in the output circuit to provide d.c. amplification to operate a neon indicator.

The circuit is also modified by the necessity of employing two diodes to prevent short circuiting of the collectors. These are generally referred to as 'steering diodes', connected as shown in Fig. 3.

For comparison, a transistorized 'trigger' circuit is shown in Fig. 4. with PNP transistors which is a true 'flip-flop' circuit in that it is switched into one state by an incoming pulse and reverts to the opposite state in the steady condition. The output in this case can be connected to read directly the number of input pulses.

Further circuits can also be worked incorporating electromagnetic latching relays (thus eliminating either valves or transistors), or the more sophisticated semiconductor devices now coming into use, such as tunnel diodes, etc., Also, of course, individual 'flip-flip' (or 'flip-flop') circuits can be cascaded or decaded to produce more sophisticated counting devices. Although these represent modern developments, it is interesting to recall that the basic circuit design for simple electronic counters was first developed nearly half a century ago.

Comtex fractional horse-power geared motor

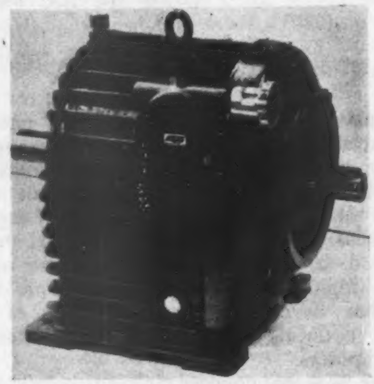
F.H.P and Geared Motors

The first of a new range of fractional horse-power motors giving a wide range of torque and output speeds introduced by Comtex Limited, 566 Cable Street, London E1, are manufactured to Class-E, BS 2757 (which allows a temperature-rise of 65° above ambient). They are known as the GL8 (motor only), GL9 (motor with single reduction gearbox), and GL10 (motor with double-reduction gearbox). They are available for single and three-phase supplies for the following ratings: 1/30 hp at 4100 rpm (nominal) 50 or 60 cps, single phase 100/110V, 200/220 V, 230/250 V, and three-phase 400/440 V.

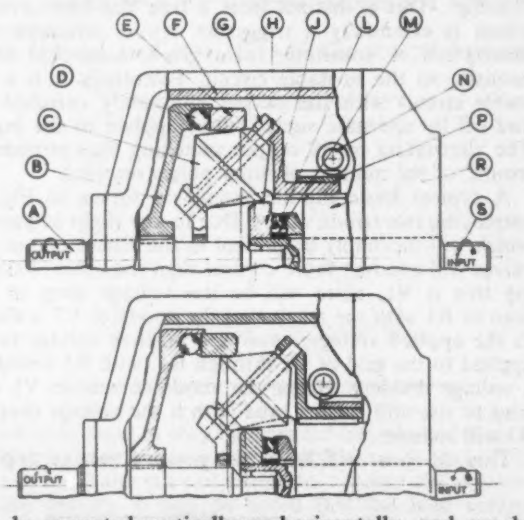
All motors, both induction and commutator type, are supplied as standard for reversing, and at no extra cost a new design of capacitor can be fitted to the rear end to make compact, self-contained units, or alternatively the capacitor can be separately mounted in the usual way. The gearboxes can be turned to bring the output shaft into a variety of positions to suit the job on hand, and practically any final output speed can be supplied. "Encapsulated" windings will be available in addition to the normal Class "E" BS 2757. Each unit carries a 12 month guarantee. All rotating parts are statically and dynamically balanced electronically.

New 50 hp Kopp Variator

With the introduction of the new 'K' type, the range of Kopp Variators has been extended to 50 hp, and depending on power to be transmitted, the output speed range has been extended to 12:1, the minimum output speed being 1/7th of the input speed. The new Variator



Kopp Variator to convert 1440 rpm to 500/2000 rpm at 50 hp or 1440 rpm to2 90/2600 at 20 hp. Below, Figs. 1 and 2



can be mounted vertically or horizontally, and can be supplied either with free shaft ends, or flexibly coupled to motors on a common base-plate.

The Variator consists of an outer casing F and endcover R in which the co-axial input shafts A and S are mounted. Power is transmitted from the input shaft through a pressure device L to the drive disc J thence to a series of double conical drive rollers C which are free to rotate on fixed inclined spindles H. The carrier G in which the spindles are located is keyed on the endcover boss and so arranged that it can be moved axially by means of the rack P and pinion N. From the drive rollers, power is transmitted to the outer ring E and pressure device D and then to the output shaft through the drive flange B. It will be apparent that with the carrier G in the position shown in Fig. 1, the ratio of the diameters on the drive rollers at the contact points indicated, will produce a low output speed. When the carrier is moved axially to a position shown in Fig. 2, then a higher output speed will be obtained.

Kopp Variators are made by Allspeeds Limited, Royal Works, P.O. Box 43, Accrington, Lancs.

Silicone Fluids for High Temperature Service

Methyl silicones although possessing good temperature stability have many limitations regarding their suitability as high temperature hydraulic fluids or lubricants. This article discusses the basic requirements of high temperature lubricants with particular reference to the performance of "improved" silicones

HIGH service temperatures represent a severe demand on fluids used as lubricants or for power transmission, the thermal stability of conventional lubricants being somewhat limited although more than adequate for a majority of applications. Mineral oils have, in fact, been worked successfully in hydraulic systems up to about 280° F although a normal service temperature limit is usually 150° F, after which inter-cooling is considered more or less obligatory.

The main demand from a hydraulic system is for a stable, chemically inert fluid with acceptable viscosity values at the extremes of service temperature encountered. At the same time the fluid must possess suitable 'oiliness' or properties as a lubricant—or 'lubricity' to quote an Americanism which is coming into common (if not universal) acceptance. Thus a good hydraulic fluid is also a good lubricant, whatever its other special characteristics, and high temperature fluids can be discussed in the general sense of having common properties for either hydraulic services or lubricants.

The principal demand initiating research and development in high temperature fluids has been for aircraft hydraulic systems and system lubricants for new and projected designs where aerodynamic heating at supersonic speeds establishes a need for hydraulic fluids capable of operating at temperatures between 400° and 570° F. This is in order to avoid the complication and additional weight of maintaining adequate cooling throughout the system whereby more conventional fluids could be used. Requirements for conventional aircraft hydraulics are very modest by comparison—a maximum operating temperature of about 160° F and a minimum temperature down to −40° F.

Apart from stability requirements of the fluid itself, viscosity characteristics at extremes of temperature are important in governing pumping efficiency. Conventional (aircraft) practice calls for a maximum viscosity of 500 centistokes with mineral oils, although double this value could be acceptable in practice and still maintain good pumping efficiency. In certain circumstances, a viscosity of 2500 centistokes may be acceptable at the lowest service temperature, if the other characteristics of the fluid are particularly attractive.

At the high temperature end, a minimum viscosity of 10 centistokes is commonly adopted where, again, mechanical and volumetric efficiency of the pump is still high. Lower values of viscosity may be accepted with some loss of pump efficiency and a figure as low as 2 centistokes is sometimes quoted as an arbitrary limit. This represents a limit at which efficient lubrication can be maintained and excessive leakage avoided. Viscosity limits are, in any case, somewhat arbitrary, the ultimate efficiency at any viscosity being largely dependent on the design and type of pump.

Table I.—REQUIREMENTS FOR HIGH TEMPERATURE FLUIDS

Property		Phase 1	Phase 2	Phase 3
Viscosity at (centistokes)	−54° C	2 500 max	—	2 500 max
	−40° C	—	2 500 max	—
	150° C	3·5 min	—	—
	205° C	—	3·5 min	3·5 min
Vapour pressure at (mm. Hg)	95° C	—	—	—
	150° C	3·0 max	—	—
	205° C	—	3·0 max	3·0 max
Pour point		−60 °C	−60° C	−60° C
Lubricity		Arbitrary or specific requirements detailed by standard test procedures		
Oxidation				
Temperature stability				
Hydrolytic stability				
Corrosion stability				
Evaporation				

As a guide to typical military requirements for high temperature hydraulic fluids (primarily as high temperature aircraft fluids, but also with high temperature lubricants in mind), Table I lists typical development aims laid down some years ago. Fluids reaching Phase 3 viscosity requirements have only recently appeared, such as OS-45 silicate base (Monsanto) and 'Silcodyne' silicones (Imperial Chemical Industries), opening up possibilities of having available 'working' fluids capable of application at service temperatures up to 500° F, although their relatively high cost may preclude their selection for general application.

At the high temperature end it is essential that a satisfactory minimum viscosity be accompanied by good stability and other suitable physical characteristics. The high temperature viscosity figure, for example, must be accompanied by good shear resistance, otherwise the inherent shear losses in the system will still further reduce the effective viscosity in service. This is even more significant because in such high-duty systems closer clearances and finer movements are almost inevitable to minimize fluid losses, which will tend to generate higher than normal shear forces.

Other significant factors include vapour pressure (a high vapour pressure tending to promote evaporation, possible seal failure, cavitation, etc.); satisfactory resistance to oxidation or corrosion; and suitable hydrolytic stability. Hydrolytic stability, in particular, may govern the 'breakdown' point of the fluid since some degree of water contamination may have to be regarded as inevitable. Some otherwise satisfactory fluids may break down under these conditions, others become excessively acid or chemically active.

All other factors being acceptable, the final criterion will be the thermal stability of the fluid as determining the maximum operating temperature. This is the temperature at which molecular breakdown of the fluid takes place resulting in a change of properties which renders the fluid no longer suitable. It may be possible on a short-term basis to accept a certain limited amount of breakdown—i.e. operate for short periods above the temperature at which breakdown actually occurs as

long as the fluid has not dissociated or deteriorated to a degree where its properties are no longer acceptable. In other words, under such conditions the fluid has a limited life.

The fluid characteristics so far discussed make no mention of compatibility with seals, etc., which is obviously another most important factor. Compatibility may, in fact, be the major problem for high temperature fluid services. Certainly conventional elastomers are quite unsuited for withstanding continuous high temperatures, calling for the development of special materials, special designs of seals, or even the elimination of seals as far as possible from the system. Ultimately, no doubt, metallic seals will come into more prominence for this class of work, possibly even to the exclusion of the elastomeric type. It is surprising how chemically active apparently 'inert' fluids can become at high temperatures and what might prove a suitable seal material for low and moderate temperatures with a particular fluid can become completely incompatible with the same fluid at elevated temperatures.

Right from the early days of development of high temperature fluids and lubricants, silicones were an attractive choice on account of their good thermal stability resistance to shear breakdown and hydrolytic stability. Silicate-base fluids have also shown excellent stability up to 200° F and can certainly be worked much higher—e.g. up to 400° F. Above this, thermal stability tends to become marginal and oxidation resistance unsatisfactory.

Methyl silicones, however, lack many other desirable qualities, notably as regards their lubricating properties. Fortunately, however, the silicone molecule is capable of being 'tailored' to overcome many, if not all, of these deficiencies, at the possible expense of making it somewhat more chemically active at elevated temperatures.

Several of these improved silicone fluids have been developed, a notable recent addition to the commercially available range being the I.C.I. 'Silcodynes'. Silcodyne-H is basically intended as a hydraulic fluid and incorporates chlorophenyl groups in the silicone polymer to yield a significant improvement in lubricating properties. Silcodyne-M has further enhanced lubricating properties given by the addition of an oxidation inhibitor to provide additional load varying capacity. Silcodyne-M is specified as both a high temperature hydraulic fluid and a high temperature lubricant designed for use as an engine oil or lubricant at temperatures from −100° F to 500° F. Typical properties of these two fluids are summarized in Tables II and III.

Table II.—PROPERTIES OF 'IMPROVED' SILICONE FLUIDS

Property		I.C.I. Fluid	
		Silcodyne—H	Silcodyne—M
Specific gravity	20° C	1·03 ± ·005	1·03 ± ·005
Bulk modulus at	75° F	130,000	150 000
	700° F	—	30 000
Pour point		below −100° F	below −100° F
Flash point	(ASTM D-92)		550° F
Fire point	(ASTM D-92)		640° F
Auto-ignition point			900° F
Specific heat B.t.u/lb/°F		0·35 at 100° F	0·425 at 100° F
		0·51 at 500° F	0·583 at 700° F
Coefficient of expansion			
	50–150° C	$9·75 \times 10^{-4}/°C$	—
	150–200° C	$11·11 \times 10^{-4}/°C$	—
Max. service temp. (no deterioration)		600° F	550° F
Breakdown at 700° F (at atmospheric pressure)		2% per hour	4% per hour

Table III.—VISCOSITY CHARACTERISTICS OF IMPROVED SILICONE FLUIDS

Temp.		Viscosity (centistokes)	Temp.		Viscosity (centistokes)
°F	°C	Silcodyne—H	°F	°C	Silcodyne—M
−76	−60	3000—4000	−68	−54	2848
−65	−54	2200	−30	−30	705
−40	−40	630—650	0	−16	310
32	0	190	100	38	65
100	38	40	210	99	22
210	99	16	300	149	13
450	232	4·3	450	232	5
700	370	1·8	700	370	2

The particular difference between the thermal stability of silicones and other conventional lubricating fluids is that with the latter oxygen acts as both a reactant and a catalyst, so that oxidation resistance is part of thermal stability, and breakdown occurs at the same places in the molecule. In the case of silicones the fluid consists of an inorganic structure and an organic structure and thermal stability and oxidation effects are separately confined. Under oxidation conditions the organic (methyl) part reacts to form small amounts of formaldehyde from a typical polysiloxane molecule, and cross linking the silicone molecules with an oxygen bridge. Under strict thermal breakdown the inorganic portion is affected, breaking the bonds linking the silicon and oxygen atoms in the molecules.

The result of oxidation or cross linking with an oxygen bridge between the silicone atoms from which the methyl groups have been removed is an increase in the molecular weight and viscosity of the silicone. All silicone fluids are, however, strongly resistant to oxidation, even under conditions of total air saturation, and have a characteristic threshold temperature below which oxidation cannot take place. This threshold temperature, typically, is of the order of 500° F. Above the threshold temperature the rate of oxidation may still be very low, depending on service conditions, but increasing with increasing temperature. It remains very much lower than conventional fluids however—e.g. less than one tenth.

Thermal breakdown, generally, will tend to take place at a somewhat higher temperature than the onset of oxidation, although this will be affected by the presence of contaminants which might have a catalysing effect, and also to some extent on the system pressure. Under 'clean' conditions, Silcodyne-H is stable up to 600° F (plus or minus 20° F) and the decomposition rate at higher temperatures is linear rising to 2% per hour at 700° F. In the case of Silcodyne-M, the additives have a slight de-rating value on thermal stability, 550° F being the maximum temperature quoted for indefinite life (no decomposition), and a breakdown rate of 4% per hour at 700° F. Fluid life at 600° F under strict thermal conditions is quoted as 50–100 hr.

The breakdown products are low molecular weight silicones which tend to be volatile at very high temperatures but are soluble in the fluid at lower temperatures. They are non-corrosive and non-abrasive and can be removed from the bulk of the fluid with conventional deaeration equipment. An increase in pressure tends to inhibit decomposition—i.e., whilst decomposition may still take place above the activation temperature, the rate of breakdown is appreciably reduced with increasing pressure. A typical working figure obtained with Silcodyne-H fluid under 1500 psi pressure is a breakdown rate of 0·25% per hour at 700° F over a period of 24 hr continuous operation at this temperature.

The bulk modulus of silicone fluids is generally low —roughly one half that of conventional fluids and lubricants at normal temperatures. Thus provision may have to be made for its greater compressibility in the

design of system component, etc. On the other hand, the greater thermal stability of silicones means that a relatively high bulk modulus is achieved at high temperatures—e.g. 30,000 psi at 700° F. Bulk modulus variation is, of course, pressure dependent—see Fig. 1.

Silicone fluids have a high viscosity index, so that the degree of change of viscosity with temperature is low.

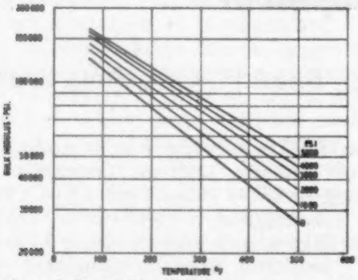


Fig. 1.—Approximate bulk modulus of "Silcodyne H" showing variation with pressure

A silicone fluid having a viscosity of 5 centistokes at 450° F will show a rise only to the order of 300 centistokes at 0° F; and a fall to 2 centistokes at about 700° F.

Vapour pressure characteristics of silicone fluids will depend very much on the formulation. Where the fluid consists of a mixture of polymers the resulting vapour pressure will be essentially that of the lowest boiling compound which may constitute only a fraction of one per cent of the total bulk of fluid. At the temperature where the fluid is no longer thermally stable, vapour pressure will tend to rise rapidly because of the breakdown or depolymerization of the constituent molecules. Some silicone fluids, therefore, may have no appreciable vapour pressure up to the 'breakdown' temperature; others, relatively higher values, and again rising very rapidly at the breakdown temperature—see Table IV.

Table IV.—VAPOUR PRESSURE OF 'IMPROVED' SILICONE FLUIDS

Temperature		Vapour pressure mm Hg	
°F	°C	Silcodyne—H	Silcodyne—M
77	25	5·5	less than 1
150	65	8	less than 1
300	149	22	1·2
450	232	50	4·3
600	315	80	8·5
>600	>315	rapid rise	rapid rise

Table V.—SHELL FOUR-BALL WEAR TEST *
(one hour at 600 rpm)

Fluid	Temperature	Wear Scar Dia (mm) Steel on Bronze 10 kg load	Steel on Steel 50 kg load
Dimethyl silicone	ambient	2·0	1·91
Methyl-Phenyl Silicone (25% M Phenyl)	ambient	2·53	4·18
Silcodyne—H	ambient	0·50	0·55
	150° C	0·64	1·59
Petroleum oil	ambient	0·49	0·50
	150° C	1·81	2·09
Diester fluid	ambient	0·49	0·79
	150° C	1·48	1·02

*I.C.I. Limited (Nobel Division)

Table VI.—LOAD CARRYING ABILITY *

Fluid	Load to cause film failure (kg) 100° C	(400° F) 205° C
20% Phenyl silicone	5	1
Methyl silicone	20	15
Silcodyne—H	40	30
Silcodyne—M	45	38
Petroleum Lubricant	70	50
Diester Fluid	130	100

*I.C.I. Limited, test figures on Shell four-ball tester

Comparison of the lubricating properties of different fluids is usually difficult to assess, except under practical working conditions. The Shell four-ball wear test is, however, quite widely accepted as a standard where the lubricating properties of a fluid—or lack of lubricity—is a function of the wear scar size produced. Some typical test figures are given in Table V which clearly indicate the limitations of normal methyl silicones and the enhanced properties realized by retailoring the molecule. Under extreme pressure conditions similar improvements are realized. The employment of an oxidation inhibitor to provide additional load-carrying capacity, incidentally, has little effect on seizure point but rather tends to decrease wear at lower loads. Under typical gear tests the 'improved' silicones rate some ten times better than dimethyl silicone, with conventional petroleum-base lubricants and diester fluids some two to three times better again. With increasing temperature the relative performance of the 'improved' silicone fluids is, of course, enhanced.

Silicone fluids, in general, are non-toxic, essentially neutral (so that an acid number as commonly determined on petroleum-base fluids no longer applies) and non-corrosive to most metals. At high temperatures copper is attacked, although many bronzes may be suitable. Aluminium and magnesium are attacked at high temperature and high pressure. Low carbon steels are suitable for tubing, but high carbon stainless steels or tool steels are preferred for component construction, where applicable, in high duty systems. For optimum performance with the improved silicone fluids it is usually essential that steels used for rubbing surfaces should contain carbon converted to carbide by heat treatment.

Conventional elastomers are generally compatible with silicone fluids up to 350° F but at higher temperatures (up to 500° F) Viton is normally required. At such temperatures, however, the suitability of any elastomer for a dynamic generally becomes questionable. Carbon seals prove satisfactory where a small but continuous flow of fluid can be maintained over the seal face. For high-temperature high-pressure systems it is generally recommended that stainless steel tubing be used throughout with welded joints (since this material is difficult to flare properly).

Fault Warning System

The new Gresham fault warning system, designed and manufactured by Gresham Automation Limited, Gresham House, Hanworth, Middlesex, for monitoring and calling attention to faults in any type of automated system is in the "solid state", that is transistorized with printed circuitry. The system is manufactured in modules in such a way that the fault warning system is individually tailored to service any number of control or measurement points in any type of automated plant. It is designed to actuate audible warnings through loud-speaker amplifiers, through buzzers and also visual indication of the location of the fault either at points on the plant, or in the control room or both. It may be completely self-contained so that it indicates when the fault is being attended to and when it has been corrected. The system can also be used for indicating and, by suitable connexions, recording fleeting faults which occur and correct themselves before a supervisor has had time for action. Power is via a Gresham power pack or any low voltage d.c. source.

Nuclear Energy: 1959–1960

A chronological survey of the principal events in research and development

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

1960

October

The nuclear-powered U.S. submarine "Scorpion", visited Portsmouth, England.

The boiling heavy water reactor plant at Halden, Norway, produced boiling water for the first time. During the experiment the reactor reached a rating of 2 MW. The thermal capacity of the first core, fuelled with natural uranium, is 5 MW. The second core, with 1.5% enriched uranium, is to produce 10 MW and, at a later stage, 20 MW.

The Second Accelerator Conference was held in Amsterdam.

West Germany decided to proceed with a nuclear ship propulsion programme costing 70 million DM (£5,800,000). It was proposed to build an atomic-powered research vessel within five years.

The nuclear power station at Dresden, Illinois was dedicated. Its single boiling light water reactor has a thermal rating of 624.2 MW, the highest for reactors so far built in America. The station output of 180 MW (net) is obtained from one generator of 192 MW (gross).

The advantages of the separation of uranium isotopes by the German centrifuge process were reemphasized at a discussion in Washington between the United States and West Germany. Although the principle was considered by the Allies during and after World War II, its development was primarily due to the German firm, Degussa and Wilhelm Groth, based on Gernot Zippe's patent of June 1960, who at the time was doing research under contract with the U.S.A.E.C. at the University of Virginia. He left in July 1960, after rejecting offers from U.S. firms. Although the intial cost of the centrifuge unit is about twice that of comparable equipment in a gaseous diffusion plant, the power consumption is about 10% for the same amount of separation, representing a saving of 90%. The U.S.A.E.C. were spending on diffusion about $634 million (£227 million) per year to produce 77,777 kg, per year of uranium with an enrichment of 90% corresponding to $8149 (£2910) per kg or £1320 per lb. The power consumption is 2,940 kW hr. The estimated cost of centrifuge units is approximately $300 (£107) per kg of 90% enriched uranium compared with $133 (£47.5) for the existing diffusion plants.

The French Atomic Energy Commissariat announced that they proposed to dump 6,500 barrels of atomic waste on the bed of the Mediterranean, midway between the French coast and Corsica, at a depth of 8,500 ft. The waste, produced during the process of extracting plutonium from irradiated bars of uranium at the atomic centre of Marcoule, near Avignon was in the form of mud and contained particles of radio-active lead, iron, zirconium, caesium-137 and strontium-90; it is stored in about three feet high drums, made of sheet steel and filled with concrete which encased the waste. As a result of protests the operation was postponed.

The death occurred of Professor Abram Federovich Joffe (b. 1880), the distinguished Soviet physicist, who was responsible for the testing of Russia's first atomic bomb in 1949.

The U.S. Navy announced that the nuclear-powered submarine "Patrick Henry" has successfully fired four combat-type Polaris missiles during the 17th—18th October. some 500 miles off the coast of Florida, the submarine being submerged during the firing.

The United States Army stated that operational testing of the 2,000 kW reactor plant, located under the Greenland ice cap 800 miles from the North Pole, had begun.

The first official disclosure was given by the Soviet Union that they have a nuclear submarine armed with rockets.

Britain's first nuclear submarine "Dreadnought" was launched at Vickers Armstrong Limited, Barrow-in-Furness. It cost £20 million and will be commissioned in

Table I.—PARTICULARS OF THE U.S. NAVY'S POLARIS-CARRYING NUCLEAR-POWERED SUBMARINES

1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Date			Displacement		Dimensions			Reactor	
Item	Nomenclature	Hull No.	Name of vessel	Keel laid	Launched	Completed	Standard (surface)	Submerged	Length	Beam	No. of propellers	No.	Type
							ton	ton	ft	ft			
1	SSBN	598	George Washington	1.11.57	9.6.59	Dec. 59	5600	6700	380	32	2	1	PWR
2	SSBN	599	Patrick Henry	27.5.58	22.9.59.	19.10.60	5600	6700	380	32	2	1	PWR
3	SSBN	600	Theodore Roosevelt	20.5.58	2.10.59	—	5600	6700	380	32	2	1	PWR
4	SSBN	601	Robert E. Lee	25.8.58	18.12.59	Sept. 60	5600	6700	380	32	2	1	PWR
5	SSBN	602	Abraham Lincoln	1.11.58	2.4.60	Dec. 60	5600	6700	380	32	2	1	PWR
6	SSBN	608	Ethan Allen	14.11.59	22.11.60	—	5900	7000	410	33	2	1	PWR
7	SSBN	609	Sam Houston	—	—	—	5900	7000	410	33	2	1	PWR
8	SSBN	610	Thomas Edison	—	—	—	5900	7000	410	33	2	1	PWR
9	SSBN	611	John Marshall	—	—	—	5900	7000	410	33	2	1	PWR

1962. The nuclear reactor which is of the pressurized light water type was bought intact from the General Dynamics Corporation. The core consists of uranium plates cladded with zirconium. The light water is circulated between these plates and extracts the heat produced by the nuclear fission. The "Dreadnought" has a length of 266 ft, a beam of 32 ft, a draught of 17 ft, a surface and submerged displacement of 3500 and 4000 tons respectively and a crew of 11 officers and 77 ratings. She has two propeller shafts, driven by geared steam turbines, which enable her to maintain a speed of about 30 knots. A prominent feature of her design is her whale-shaped hull which gives optimum under water performance. The nuclear propulsion plant was designed and manufactured by the Westinghouse Electric Corporation; Rolls Royce and Associates Limited, which includes Foster Wheeler Ltd and Vickers Ltd, acted as agents for the Admiralty. The Royal Navy's second nuclear submarine which is to be larger than the "Dreadnought" is to be powered by an entirely British built nuclear plant and is expected to join the fleet in 1964, the contract being placed with Vickers-Armstrongs (Shipbuilders) Ltd and Rolls-Royce and Associates Limited. These first two British nuclear submarines are not designed to carry nuclear weapons such as the Polaris II missile.

It was proposed to build at Risley, about midway between Manchester and Liverpool, a nuclear reactor which the universities of these two cities are to share. This will be a smaller version of the Hawker Siddeley Nuclear Power Company's "Jason", using enriched uranium with graphite reactors and moderated and cooled by light water.

Work started on site at the Schulten high temperature reactor in Stetternich forest near Jülich, Cologne. Costing about 40 million DM (£3.41 million) it is the second German nuclear station and the first to be designed and manufactured entirely by German firms. This 15 MW(e) station has a homogeneous gas cooled, graphite moderated, enriched reactor and a gas turbine as the power generating plant. The designers are Brown Boveri -Krupp and the owners A.V.R., Dusseldorf.

A long term agreement was made between the General Electric Company Limited, England, and the Nippon Denkyoku Kabushiki Kaisha to manufacture in Japan special types of nuclear graphite.

Abbreviation	Shipbuilder
EBD	Electric Boat Division of the General Dynamics Corporation, Groton, Connecticut.
MINY	Mare Island Naval Yard, Virginia.
NNSY	Newport News Shipbuilding Yard, Virginia.
PNY	Portsmouth Naval Shipyard. New Hampshire.
WE	Westinghouse Electric Corporation
GE	General Electric Company.

15	16	17	18	19	20	21
Compliment			Builder			
Officers	Ratings	Total	Vessel	Reactor	Main turbines	Total cost
10	90	100	EBD	WE	GE	$98.67 million (£35.2 million)
10	90	100	EBD	WE	GE	
10	90	100	MINY	WE	GE	
10	90	100	NNSY	WE	GE	
10	90	100	PNY	WE	GE	
—	—	—	EBD	WE	GE	$105 million (£37.5 million)
—	—	—	NNSY	WE	WE	
—	—	—	EBD	WE	GE	
—	—	—	NNSY	WE	WE	

November

Britain agreed to provide an anchorage in Holy Loch, Firth of Clyde, for the U.S. nuclear-powered submarines, carrying the Polaris missiles. However, no warheads or missiles will be stored, but a depot ship U.S.S. "Protheus" (18,500 ton) is to be established in Holy Loch and a floating dock and supporting vessels will equip the anchorage. The essential particulars of the nine Polaris carrying submarines in commission or under construction are indicated in Table I.

The Minister of Power approved the issue of a licence to Queen Mary College, University of London, to proceed with the installation of a 10 kW "Jason" Mark III reactor at the college's Department of Nuclear Engineering, the first University reactor to be installed in London. Designed and manufactured by Hawker Siddeley Nuclear Power Company, it is to be similar to the "Nestor" at Winfrith.

Dr. Donald A. Glaser, (34), of the Berkeley University of California, was awarded the £15,585 Nobel Prize for Physics for his invention of the "bubble chamber" which is used to-day to study the behaviour of electrons. The principles of the "bubble chamber" are a necessary aid to the observation in the very fast atomic particles, produced by powerful accelerators. Essentially it has much in common with the "cloud chamber" invented by C. T. R. Wilson (1869-1959) about 40 years ago, but in practice is more accurate. Oxford University has received a grant of £33,000 for a large helium "bubble chamber" at the Clarendon Laboratory.

Professor Willard Libby, (51), a former member of United States Atomic Energy Commission, was awarded the Nobel Prize in Chemistry for his method of determining the age of organic matter based on the rate of disintegration of radioactive carbon-14, used in archaeology, geology, geophysics and other branches of science.

An advanced prototype of the Polaris missile was successfully fired over 1600 miles, 300 miles more than any previous Polaris had travelled. The rocket of the Polaris A2 is much longer and more powerful than the A1, and will have an eventual range of 1,735 miles.

The U.S. nuclear-powered submarine "George Washington" left Charleston, South Carolina, for two years at sea, armed with 16 Polaris missiles.

The Polaris nuclear-powered U.S. submarine "Ethan Allen" which can fire atomic warheads at least 300 miles further than the previously cited submarines was launched at Groton, Connecticut, the shipbuilders being the Electric Boat Division of the General Dynamics Corporation. She is the first of five advanced nuclear submarines, having 16 Polaris A2 and a much improved hull. The very latest Polaris nuclear submarines are to be known as the "Lafayette" class. So far four have been planned and with a length of 425 ft and a surface displacement of 7,000 ton will be the largest under water craft ever built.

Britain's attack submarine "Orpheus", the second of the "Oberon" class of the conventional diesel-electric type, was commissioned at the Vickers-Armstrongs shipyards at Barrow-in-Furness.

The Electricity (Amendment) Bill was read for the second time in the House of Commons. This will give the Central Electricity Generating Board power to produce radioisotopes from the irradiated materials provided from their nuclear reactors and it is proposed to use the nuclear power stations at Bradwell and Hinkley Point for this purpose. *To be continued.*

Production Practice:

Bending Tube on a Hand Press
Grinding Thin Strip
Boring the Steady Bearing of a Milling Machine

By JOHN WALLER

IN the majority of workshops engaged on general work the bending of small tubes is carried out on a hand machine—the straight tube is clamped and then gradually turned round a roller by the action of another swinging round a fixed centre, and though this method gives accurate results it does not compare with the press for speed when production is the keynote rather than carefully bent tubes. There was an occasion when the only requirement of a bent tube was that the ends pointed in the desired direction. With this in mind it was decided to replace the bench method by a hand press, the two bends being made together.

Two large outer rollers A (Fig. 1) mounted on flanged pillars D, were placed with the grooves correctly aligned to make the initial location and an endwise spotting achieved with the angle plate and stop plate B and C; thus the tube was first dropped on to the rollers and then pushed against the stop plate which was sufficiently accurate for the class of work expected. The angle plate was dowelled to the base E and the pillars fitted into bored and recessed holes and held securely by a bolt underneath the base.

The punch was welded and comprised a forked bar and stalk which fitted the press ram, and two rollers G rotating in the forks were used to form the tube. These latter rollers were smaller than these first mentioned. All four rollers were free on their spindles which were short but rather large diameter pieces of silver steel.

The most efficient way of bending these tubes in this way is to bring the upper tool down to within $\frac{1}{2}$ in. of the straight located tube, and then exert a steady downward push, avoiding a sudden jerk which could cause damage to the outer wall of the tube. If conduit is formed the latter is not so important, but of a slight angle on each side of the radius machined on the rollers acts as a lead and eliminates the odd sharp corner that causes a badly scored surface.

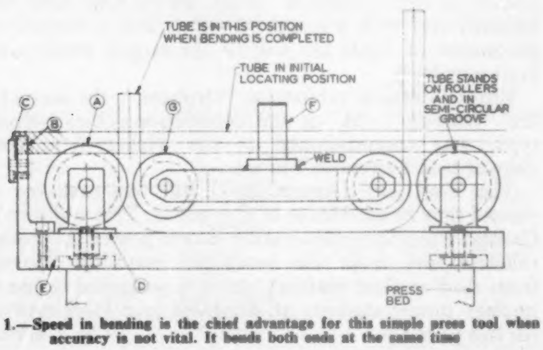


Fig. 1.—Speed in bending is the chief advantage for this simple press tool when accuracy is not vital. It bends both ends at the same time

Setting the top tool is done by lowering the press ram until the rollers locate over the tube, and then tightening the screw securing the stalk; a flat machined on this diameter at the appropriate position makes its setting permanent but individual setting is preferable.

Whether the rollers require case-hardening depends on the number of pieces being bent; for a hundred or so this operation is omitted on the grounds of economy, but for a large number of tubes, heat treatment followed by polishing gives long life free from pitting.

When the tube is pushed down into contact with the baseplate the ram is reversed. If considered necessary the outer rollers can be raised slightly to bring their centres a little above that of the inner rollers. This helps to set the tube arms more accurately.

Thin components or strip material which range in thickness from 0·01 in. to $\frac{1}{32}$ in., are often difficult to grind successfully due to distortion as the grinding wheel passes over the surface causing a localized heating and distortion resulting in the work being thin in the centre. A vacuum chuck to meet this circumstance is illustrated in Fig. 2. It is fabricated from $\frac{1}{4}$ in. thick steel plate to form a box section, and then the base is lightly surface ground for seating on a magnetic chuck. Three ribs are included to add further support to the upper plate which is made from copper as this material conducts the heat away quickly and this is secured to the base by a series of screws set well down beneath the top face of the plate.

The side wall at one point is thickened to accommodate a threaded hose union or similar fixing, and each inner

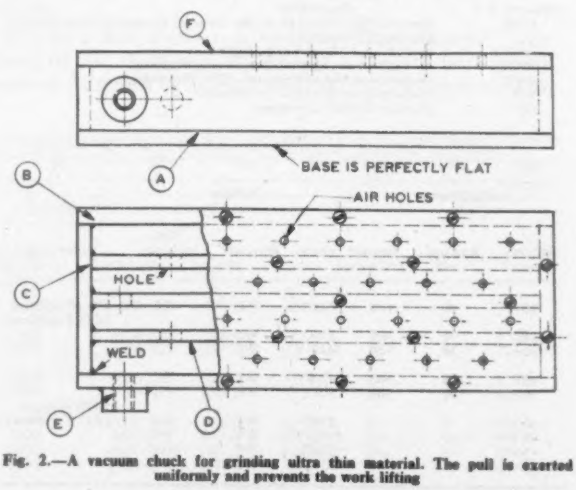


Fig. 2.—A vacuum chuck for grinding ultra thin material. The pull is exerted uniformly and prevents the work lifting

wall is drilled to provide interconnecting passages between the walls. Thus when air is extracted by means of a pump through the hose, all passages are exhausted. Holes drilled at intervals through the copper plate are spaced at suitable distances apart according to the size of the workpiece—the removal of small burrs by very slight countersinking is obviously important to allow the strip to seat correctly.

In use care is taken to see that the workpiece completely covers the holes. If the chuck is used for a range of details which may leave several uncovered at different times, the latter are either temporarily plugged with plasticine or by a grub screw if the hole is tapped for that purpose. For wide components a host of small holes is preferable to using merely a dozen spaced round the edges of the part. Again, for narrow strips a close spacing at intervals of 1 in. or less, does avoid even the smallest length of strip from rising and so being ground thin in the manner mentioned above.

Refinements to this type of chuck include the provision of a minutely raised edge against which a strip or component about 0·025 in. can be pushed for the removal of a small amount of material parallel to the edge of the part, and the edge of the chuck is also ground parallel with this setting edge for location on the magnetic chuck. Alternatively, clamping pieces for securing the chuck to the machine table are required. The minimum thickness of the top plate is $\frac{1}{4}$ in. and a light skim by the wheel before attempting to locate the work ensures that the face is flat and true with the table surface.

The complete renovation of any machine tool is a major task and in large works handling components of a general character a number of the same type and size of a particular make of machine is continually being brought in for overhaul, and the shop concerned can frequently undertake the manufacture of simple yet effective jigs or pieces of equipment to make assembly easy and accurate. One operation that arises at frequent intervals is the boring of the outboard steady bearings on a milling machine, and as these range over a host of sizes the production of a special bar for the operation together with a simple locating device to impart the necessary cross motion, is well worth while, and the resulting hole is then exactly in line with the machine main bearings.

Consideration of general needs is the initial stage because one mandrel will usually suffice for several machines; thus the emphasis is on the massive machine as a tool designed for the latter is often usable on the lighter miller, but one specially designed for the baby machine is much too flimsy on a heavy machine and is likely to leave severe chatter marks in the bore. Rather than make several bars, a holder with two bars will usually bore all the required sizes, and by restricting the amount the holder stands out from the machine spindle, there is little opportunity for chatter to occur.

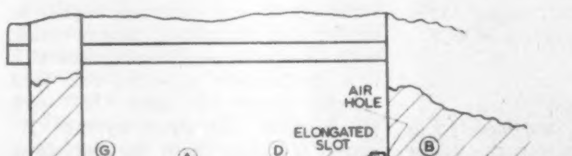


Fig. 3.—Accurate alignment of the steady bearing with the mandrel taper is secured with this type of set-up

Fig. 3 shows a view from the end of a miller and use is made of the machine table as a means of providing the necessary feed to the cutter while the rotary motion is obtained from the machine spindle. The steady is secured to the overhead arm and has the necessary bush which has been rough bored about $\frac{1}{16}$ in. smaller than the size necessary to allow it to fit closely over the machine mandrel, and the arm is set to reduce the degree of overhang as much as possible and so the bar A is well back inside the secondary bar or holder B. The latter is fitted to the machine taper spindle and to facilitate manufacture the central hole is bored through and then the end is filled with a threaded insert to accommodate a draw bar. This insert C is held securely by means of a grub screw or pin to prevent it rotating by the action of tightening the draw bar. The other end of this holder is milled through into the bore and an elongated slot is formed which fits the hexagon shouldered screw D.

A piece of high tensile steel is the best material for the bar A and except for the close fitting diameter which slides back and forth in the holder, the remaining details offer little need for comment. A tool—preferably tipped if a number of bearings require boring, but not really essential as a high production is not anticipated with this class of work—is provided, and this is held in place by a socket grub screw in the conventional manner. Whether another grub screw immediately behind the tool is fitted depends on the size of the bar, but as this is generally impossible as the latter is so small, adjustment is accomplished by loosening the clamping grub screw and tapping the tool gently to move it outwards and so cause it to enlarge the bore. The rotary motion of this bar is obtained by the hexagon screw fitting a tapped hole in the bar, and various positions are obtained for the bar in a lateral direction by providing a series of tapped holes along the bar shank.

Movement to feed the tool through the bore is obtained from the fabricated bracket F, which is welded and then milled to form the deep slot in which the bar A rotates; thus a movement in the direction of the arrow causes the bracket to push against the flanged portion of the bar and so impart feed to the tool. When feeding is completed and the bar and bracket require dismantling from the miller, the machine table is lowered and the bar is freed from the slot; slackening the draw bar and removing the holder is then done as for the machine mandrel. Unless the bar A requires changing there is no need to loosen the hexagon screw D as this retains both parts together and lessens the chance of their being lost.

The crux of this style of boring is the degree of fit given to the sliding portion. They must obviously slide together, but a fit close to a push fit is preferable as this obviates any slackness and chatter.

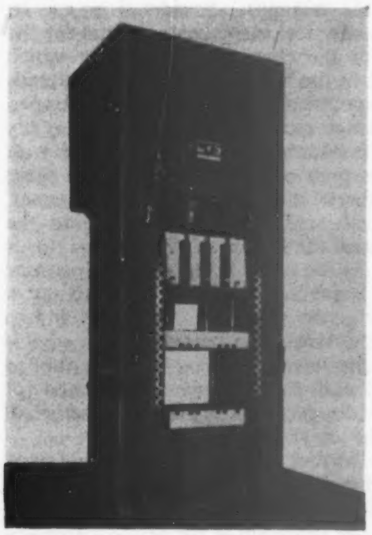
Every opportunity is taken to strengthen the bars by adding radii and chamfers, and a light feed together with several cuts lessens the chance of vibration. The rule is to proceed cautiously and with care and then the result is a perfectly aligned bearing in the outboard steady.

Machine Tool Record

Double-action Deep Drawing Presses

The EMD150, a double-action double-sided deep drawing press of Belgian manufacture has bed, crown and two side frames of rigid all-welded steel construction; the complete frame is normalised after welding and before machining and the slide faces of the guideways are covered with phosphor bronze. The cylinder is of high-tensile steel, the neck bored to receive a phosphor bronze guide bush and an automatically adjustable gland packing. All packings are of synthetic rubber; The differential piston is of special iron; the piston rod is of steel; and bronze bushing is provided for guiding the piston rod in the cylinder.

The blankholder rests on the ram, and is guided between the slide faces of the press. It is actuated by four rams, pressure regulation being infinitely variable and independent for each. The press is driven electro-hydraulically, the combined system permitting semi- or fully-automatic operation. Fitting and adjustment of the tools is by hand. A special push button is provided for stopping the ram in any desired position. The adjustment of the stroke in either direction is effected by means of two electrically operated stops. The press is also equipped with a braking device which brakes the slide $\frac{3}{4}$ in. before closing of the tools. Overloading is impossible because a safety valve is provided which prevents the pre-set tonnage being exceeded.



150-ton electro-hydraulic press for semi or fully automatic operation

The multiple-piston axial pump, mounted in the oil tank, contains a main shaft, usually coupled with a flexible coupling. Delivery of the pump is at varying ratio to the pressure. The complete hydraulic drive and the oil tank are mounted on the top of the machine frame. During the closing stroke of the slide, oil is drawn in through a filling valve and during the upward travel of the slide the same valve opens automatically to evacuate the oil above the oil piston. An air filter prevents any over or under pressure when oil is rising or falling, and also prevents condensation.

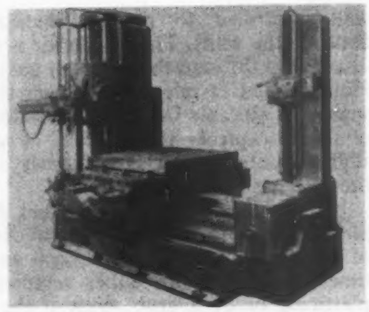
Maximum pressure of the punch ram is 150 ton; blankholder 75 ton. Maximum stroke of the punch ram is $23\frac{1}{2}$ in.; blankholder $11\frac{1}{2}$ in. Maximum distance between table and ram is 49 in. The table measures 39 in. × 39 in. and the ram 49 in. × 39 in.—F. J. Edwards Limited, 359-361 Euston Road, London N.W.1

Tool-room Boring Machines

The Kearns Optimetric horizontal tool-room surfacing, boring milling drilling and tapping machine, model 721P, combines the travelling spindle with a patented built-in automatic facing chuck. This together with the patented optical system and machine capacity, gives features of versatility not previously available on tool-room boring machines.

The facing chuck is carried on a forged steel sleeve running in two long parallel bearings, one placed well forward so that overhand of the cutting tool is reduced to a minimum. Housed within the sleeve is a nitrided bush virtually free from wear which rotates on precision type ball and roller bearings. The spindle can be revolved independently, or in conjunction with the facing chuck.

A special channel in the main bed, directly under the centre line of the travelling spindle, constitutes both the longitudinal guide and one of the primary load-bearing surfaces of the saddle. The channel houses the longitudinal screw and shaft together with their associated mechanisms. It is filled with lubricant and these parts, including the centre bedway, are submerged in an oil bath.



Kearns Optimetric horizontal tool-room surfacing, boring, milling, drilling and tapping machine, model 721P, with patent tool holding device

A cushioned drive is provided by a special toothed belt between the main motor and the change speed gear box, with a flat belt of plastic in combination with chrome leather between that unit and the drive to the spindle slide. A $7\frac{1}{2}$ h.p. main drive motor is bolted at the back of the main bed in a position where any heat or vibration generated has a minimum effect on the machine. Unit construction is employed, each unit having its own automatic and independent lubrication system.

The tool holding device has a hydraulic release operated by a rotary switch in the main control pendant of the machine. To ensure constant accuracy when holding the No. 40 non-stick mandrels in the spindle nose, the central draw bar is pulled into position by a powerful spring housed at the end of the main spindle: no danger can arise from hydraulic failure. To release tooling, the spring is overcome by applying hydraulic pressure to a cylinder attached at the end of the spindle. A bayonet catch enables rapid tool replacement, and electrical interlocks ensure that the spindle cannot rotate with tooling in a released position.

A mechanism provides two feed ranges named "B" and "M" with six in each. The drive to the "B" range is taken from the travelling spindle and gives a feed rate per revolution of the spindle; it is easily adapted for screwcutting. The "M" range is in inches per minute and is obtained from a constant speed driving shaft in the main drive box. This feed is independent of the spindle speed.

The Optimetric system is provided to the vertical adjustment of the spindle slide and boring stay bearing as well as to traverse movements of the table, enabling settings to be

made to 0·001 in. or 0·01 mm to a limit of error of plus or minus 0·00025 in. or 0·005 mm. respectively.– H. W. Kearns & Co. Limited, Broadheath, Nr. Manchester.

Sheet Metal Working

The latest development of the Pullmax P.1. type machine known as the P.1.S. is the result of continuing efforts to simplify production of sole and nail clenching plates in the

Pullmax P1 machine for freehand cutting of irregular shapes from sheet

shoe last industry, but the machine also will find numerous applications in the freehand cutting of irregular shapes from sheet. It basically consists of a P.1. type workhead mounted in a frame with a short throat, which may be easily mounted on a conventional-type bench or alternatively on a simple beam extending from the bench for other applications, this method providing extra scope for movement of the operator through an arc of 180°.

The method usually employed for sole and nail clenching plates is to cut the blank from the metal sheet slightly oversize. The blank is then trimmed to size by the use of a template. The machines, however, are adaptable to somewhat varying methods according to the particular type of production.

Produced by Pullomax (Gt. Britain) Limited, Pullmax machines are sold by Alfred Herbert Limited, Factored Division, Red Lane Works, Coventry, the sole agents for the United Kingdom.

Magnetic Stand for Power Drills

The Magcodrill drill stand comprises basically a magnet and stand to which can be attached any make of drill, whether air, electric or high frequency. To set up, the stand is placed in position on the job to be drilled and, having been plugged into the mains supply, a weak field is induced by means of the variable rheostat, which has the effect of clamping the stand to the job in progress yet leaving it sufficiently moveable for the head to be accurately centred over the jig, centre-pop or pilot drilling. Full magnetic force is then induced by turning the rheostat to full power. The drill can then be operated and because of the stand, the hole will be driven straight through in a square manner. The stand can be used for vertical or overhead work, a safety chain being provided for the latter, and also for applications where it is impossible to get a normal drilling machine.

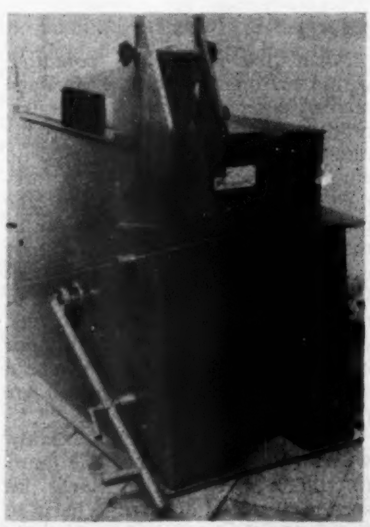
The model illustrated is the MD2 which takes up to a ¾ in. drill and costs £45. Other models in the range are available to take drills up to 1½ in. with a corresponding price range up to £75. Drill-stands can be supplied for use with any a.c. or d.c. voltage or frequency, and facilities for 1 in. change of radius through an angle of 350° for easy

Magcodrill magnetic drill-stand model MD2

location, is also available on certain models. The manufacturers are Magco Limited, Lake Works, Porchester, Hants.

High Speed Cutting-off Machine

The Neva-Scimitar cutting machine cuts in a few seconds, light and heavy gauge bar, strip, tube, and sheet, in steel, plastics and non-ferrous metals. For example 2 in. × 2 in. × $\frac{3}{16}$ in. angle iron can be cut



High speed general purpose cutting-off machine

in less than two seconds to maintain a rate of 1,500 cuts per hour. Tube of $1\frac{3}{16}$ in. dia can be cut at the rate of 2000 per hour. The machine is powered by an 8 hp electric motor, specially designed for high speed running. The special alloy cutting blade, 21 in. dia, is fixed directly on the motor shaft and is easily removable for re-sharpening. A re-sharpening service is available. Capacities are: rod or bar up to 4 in. dia, tube up to 4 in., heavy sections up to 6 in. × 4 in., strip up to 20 in. × ⅜ in., sheet metal up to $\frac{3}{16}$ in. thick × any size.

The machine permits equally high speed mitre cutting, shortening, groove cutting, notch cutting, and profile cutting of angles in sheet metal.

The motor is 8 hp, 400/440v, 300 rpm including star-delta switch if desired, with motor protection switch. Dimensions are 4 ft 6 in. × 2 ft 8 in. × 4 ft 6 in. high. Net weight is 800 lb. The price ex-factory is £280 including spare blade.—Anderston Clyde Engineers Limited, Irk Vale Works, Chadderton, Manchester.

technique

—**devoted to the discussion of practical problems**
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Mechanical Handling of Cupola Slag

When a foundry cupola is "dropped", a stream of near-molten slag is spilt on the floor beneath and around the cupola. After douching with water this is commonly shovelled away and transported to the tip. At the Ford Motor Company's foundries this work has been mechanized with a 50% saving of time by the employment of a Weatherill hydraulic loading shovel, which, incidentally, is powered by a Fordson Major diesel engine. This machine has a 1 cu. yd. bucket and is 16 ft. 2in. long with the bucket lowered, and 6 ft. 6 in. wide. Three of these machines are in use at Dagenham in the two foundries, and a fourth is in use for loading coke.

Immediately the slag has been douched the shovel moves in to pick up the slag and deposit it in a road tipper for transport to the heap.

Loading shovel moving in to pick up the slag after "dropping" of cupola

Clearing away the slag from one drop takes about 10 minutes.

The loaders are standard machines except for the addition of power-assisted steering and reinforcement of the bucket bottom with $1\frac{1}{4}$ in. steel plate.

A Costs Stint for Foremen

Can a training course on shop costs benefit a foreman, or is it a waste of time for, say, an old timer who feels he knows his own department's costs inside out without going back to school? Unless a shop foreman has more than a nodding acquaintance with costs, he is not the complete production executive. Too many shop foremen seem to think that if they produce a good job, that is all that matters, whereas it is only a part of what matters. Those remarks apply with special force to the general production and repair shops where every other job is different from its predecessor.

In the big plant engaged on repetition or mass production, costs can generally be taped from day to day and, due to familiarity with the product, the production potential, within reasonable limits, is an open secret. Where piecework operates, production times are fixed by capable rate fixers, frequently in consultation with the operators and shop foremen. Production times are the important factor in costs so far as the foreman is concerned but they are not by any means the only one. Handling times, economical use of materials, storage arrangements, proper and orderly use of floor space, machine down time, to record a few, all costs money and all are reflected in the ultimate cost.

Even if a shop foreman does know what it costs in man/machine hours to run a given part through his section, it would do him no harm to hear what the costs experts have to say on the matter. He would then probably take a keener interest in the factors, other than production times, which go to make up costs. He might even learn something about how to cut the corners of those factors to which he may hitherto have given little serious thought. He would probably get the subject of shop costs into its proper perspective.

An intimate knowledge of costs is an essential part of a shop foreman's equipment and production foremen should grasp every chance to acquire such knowledge. Far from being a waste of time, taking a course on costs would be making the best possible use of it.

To the alert, ambitious production foreman, a working knowledge of costing is a constant reminder of the necessity for keeping on his toes. This need not apply to the younger foremen only. There is much in it for the old timer also, who, in his youth got little or no opportunity to learn about costing from people in a position to teach the subject. In his youth, such information was very much "under the counter", a jealously guarded secret which no foreman need know.

Costs were never mentioned to a foreman if his were low, he heard more than enough about them if they were high, but was never told about how they were arrived at. In point of fact, in those bad old days, costs were largely used to hamstring the foreman and it was recognised policy to keep him in the dark on that subject. On completion of my apprenticeship as a draughtsman, I thought a spell on costing might be an advantage to me later on and I duly approached the chief with a view to realizing my ambition. The company was a family concern employing a few hundred hands engaged on general production. The chief executive posts were filled by members of the family and the one I had to deal with got on his hind legs at the mere idea of a young draughtsman interested in the mysteries of cost accountancy. He made it abundantly clear that my unusual request would not be granted.

Present-day employees are more favoured and, unless they are too old to be interested in new adventure,

they will be well advised to take full advantage of every offer likely to increase their knowledge and their subsequent pull with higher management. Foremen nearing sixty may not be much interested and perhaps it would be a mistake to insist on their participation, although in some large plants, here and abroad, there are no exceptions. For all the staff, new courses and works visits are a must, whatever the age.

On variety production work, difficult, awkward jobs which tax the foreman's ingenuity tend to distract his attention from the cost factor. A course of study in costs would help to keep his mind focused on the subject. It would tend to give him a new outlook and would prompt him to plan in advance the best and most economical ways of executing the not-so-straightforward job or operation. Without some knowledge of costs, even good, youngish foremen tend to pat themselves on the back on "licking" the difficult job, without giving much thought to the cost or if alternative methods would not have been cheaper and just as effective. A study course on costs, backed by refreshers throughout the year, is an excellent way to sharpen the foreman's wits and make him take stock of existing methods in the light of his newly acquired knowledge. That applies, to my mind, to all but the oldest of oldtimers and—this is important—employers should see to it that significant cuts in production costs due to foremen initiative don't go unrewarded.

A. Scot.

Fitting Large Trunnions by Nitrogen Shrinking

Eight steel trunnion pins each over 2 ft across were nitrogen shrunk to fit four 100-ton ladles at the Teesdale Ironworks of Head Wrightson & Co. Limited. To fit the ladle bores, the diameter of the pins was shrunk by an average of 0.04 in.

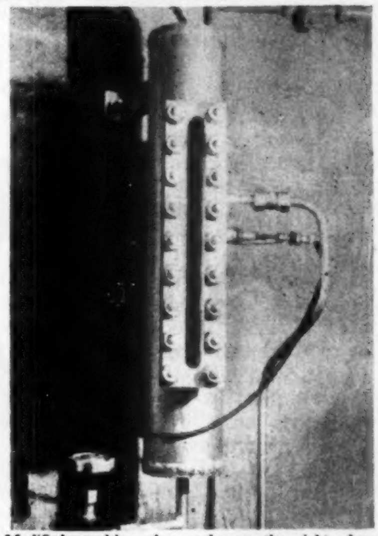
A light, insulated tank 2 ft deep was made to hold the liquid nitrogen supplied by British Oxygen. The tank could be moved on rails above the ladles which were set up on bogies. By means of a 2-ton electric hoist, each pin was lined up with the ladle bore and then raised while the liquid nitrogen tank was positioned underneath. The pin was lowered into the tank and immersed in liquid nitrogen pumped direct from a B.O.C. road tanker. On average each pin was immersed for about 52 min. A total of 1232 gal of liquid nitrogen was used.

Nitrogen shrinking was the most economical and only practical way of fitting the trunnions. Heating the ladle bore would have been much more difficult and costly and taken a great deal longer. In addition, the metal might have been distorted and weakened.

Detecting the Interface Between Oil and Water

The usefulness of a sight or gauge glass depends upon the glass remaining clear. If the liquid to be observed leaves a film on the surface of the glass then observation of the level may be rendered difficult or impossible. This happened at the Sunbury Research Centre of the British Petroleum Company Limited when it became necessary to detect the interface between oil and water in an oil cracking process plant, and due to the tarry nature of the oil the sight glass became fouled. Conductivity measurement was tried but oil on the probe interfered with detection. The capacity method was, however, successful.

A sparking plug was modified for use as a probe and inserted at the required level in the gauge glass housing as shown in the accompanying illustration. This was used with a Proximator capacity operated relay (Electronic Machine Company Limited). There is a difference in dielectric constant between water and oil which caused the relay to operate when the aqueous layer reached the probe. The relay actuated a magnetic valve which controlled the water take-off. The aqueous phase often contains small amounts of emulsified oil but it is reported that this has not affected detection of the interface by the method.



Modified sparking plug probe on the sight glass connected to capacity operated relay to detect oil/water interface

Production Method for Making up Electrical Harness

Hoover Limited have evolved a special method of mass-producing the complicated electrical harnesses for the new automated Keymatic washing machine. Because of the large numbers of different coloured wires and the complexity of the circuit design, the production of the electrical harness for the Keymatic does not lend itself to the more normal methods. Hoover design engineers have evolved a system of producing these harnesses using two parallel roller conveyors upon which the work, mounted on boards, which are in turn mounted on pallets, is passed along from girl to girl.

There are four harnesses comprising the electrical circuit of the Keymatic, the main one consisting of 16 different wires and three smaller ones. The 16 wire harness is laid out on one side of the double sided board and as this passes along the left hand conveyor each girl completes her job until it arrives in the finished state at the far end where it is removed. The other side of the board bearing the three smaller harnesses is so designed that it can be swung through 60° and is thus presented to the girl working at the far end and on the opposite side of the roller conveyor.

The smaller harnesses are then built up as the board travels back to the start via the right hand conveyor. When it reaches the end the harnesses are removed, the board swung through 60° and the assembly of the main 16 wire harness commenced once again.

One of the main attributes of this system is the small amount of floor space required and the potential number of mistakes are reduced since one girl does not handle all the wires on any one harness.

books

Engineering Drawing and Geometry. By Randolph P. Hoelscher and Clifford H. Springer. London, 1961; John Wiley & Sons Limited. 72/- net (by post 74/6). 628 pp. $8\frac{1}{4} \times 10$ in.

There are other styles of drawing besides that used in engineering. Cartography is one, the style used by architects is another, structural work calls for a style of its own and there are distinctive styles and useful conventions applicable to pipe drawings, welding drawings, and patent drawings. In the fourth section of this book the authors do a useful service in describing and illustrating all these methods.

The preceding sections deal with the details and methods of basic drawing, geometry and advanced projection systems, and technical charts and computation. It will thus be seen that the scope is comprehensive. The treatment is clear and concise and at the same time exhaustive. The illustrations are excellent.

The third section is an interesting addition to books of this kind. It covers charts and diagrams of all kinds, graphic vector analysis, graphic layouts for empirical equations, the construction and use of nomograms, and graphical mathematics from arithmetical operations to graphical differentiation and integration.

The Business of Management. By Roger Falk. Harmondsworth, 1961; Penguin Books Limited. 3/6 net (by post 4/-). 251 pp. $4\frac{3}{8} \times 7\frac{1}{8}$ in.

Anyone with an ambition to reach managerial status can learn a lot very pleasantly by reading this book. As a book for managers it holds a lot too, but for them it might be better to start at chapter II, "Ingredients of Failure", go on to chapter 10, "Successful Management", and if curiosity is thereby stimulated (in nine cases out of ten it will be) to start again at the beginning, which otherwise might be too familiar.

The author shows how management stems from leadership and acts through organisation: how it defines objectives and provides means of reaching them: that delegation, control and communication are important, and also the shareholder, the employee and the customer. He has something useful to say also on family firms, on getting the best from people, and on training managers. And when it comes to management in the future (which is what concerns young people who might read this book) he uses two recognisable characters who combine experience, knowledge, ambition and caution —equally recognisable characteristics —to paint a picture which is worth looking at very carefully by prospective candidates.

Vacuum Producing Equipment. London, 1961; Constable & Co. Limited. 18/- net (by post 18/8). 99 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Ejectors and reciprocating and rotary mechanical vacuum pumps are dealt with in this useful book which provides a complete guide to the user of this kind of equipment as regards types, performance, selection, installation and testing. A prospective user is provided with a description of the type (without any reference to make), shown how to determine the duty required and then how to select the economic size and pattern, what to do about pipes and valves in so far as there is any difference from pressure work, what instruments to provide and how to test the installation. Appendices give notes on flow etc., and conversion tables and factors.

The handbook has been prepared by a panel of The Engineering Equipment Users Association, a standardizing body whose members are predominantly users rather than manufacturers of engineering products.

Engineering Developments at the Leningrad Metal Plant Imeni Stalin. Edited by M. N. Bushuev. Jerusalem, 1960; Israel Program for Scientific Translations. 70/- 322 pp. $8\frac{1}{4} \times 10\frac{1}{2}$ in. Paperbound.

Translated from the Russian, this survey of development work at the above-named plant deals mainly with events from the twenties onwards. The original was presumably in four parts but here Parts II, III and IV only are given. Part II deals with hydroturbine building, Part III with technological and metallurgical problems in production and Part IV, entitled "In the Service of Technical Progress," deals with the role of innovators, the library, staff training and cooperation with scientists. Most of the writing is strictly technological but in the final part the dialectic does obtrude slightly. There are many illustrations.

Those interested in the Russian heavy engineering industry—and who can afford not to be—will find much valuable information in this work. The translation is published for the National Science Foundation, Washington, D.C., and the United States Department of the Interior.

Computers and Production Control.—For the past two years a subcommittee of the Institution of Production Engineers Research and Technical Committee has been investigating the possibilities of applying computers for production control applications in the manufacturing industries. A report has now been published and its contents include a description of the various types of computer; a definition of production control and how it may be applied; the use of computers in production control; the economic assessment of a computer system; the conclusion reached by the subcommittee; and illustrative case studies. Copies price 7/6 each may be obtained from the Institution of Production Engineers, 10, Chesterfield Street, London W1.

Careers.—Shipbuilding is one of the oldest industries in the world, and the opportunities for careers which it offers to young people about to leave school are outlined in a new booklet "Shipbuilding and Shiprepairing", No. 95 in the Choice of Careers series, published by the Central Youth Employment Executive, (H.M.S.O. 2/- net). Another new booklet, No. 105 in the same series, "Careers in the Iron and Steel Industry", (H.M.S.O. 2/6 net) describes the opportunities offered in both sides of the industry—the making of steel, and its conversion into shapes and sizes required.

Journal of Production Research.—The first issue has appeared of *The International Journal of Production Research* published by the Institution of Production Engineers 10, Chesterfield Street, London W1. The new quarterly journal will embrace all aspects of production—production policy, planning and control; industrial skills; productivity measurement and production processes in all technologies; and will comprise original reports by university and industrial research workers for the benefit of other research workers and of university and college lecturers. Annual subscription to non-members is £5. 5s. 0d.

BUSINESS & PROFESSIONAL

Personal

AMONGST the awards of medals announced by The Royal Society is that of the Hughes Medal to **Professor A. H. Cottrell, F.R.S.**, Goldsmiths' professor of metallurgy in the University of Cambridge, for his distinguished work on the physical properties of metals, particularly in relation to mechanical deformation and to the effects of irradiation.

ASSOCIATED ELECTRICAL INDUSTRIES Limited announce the appointment of **Mr. C. R. Wheeler** as deputy chairman of AEI as from January 1, 1962, and deputy chairman of the AEI management companies. **Mr. B. Pringle, M.B.E.**, consultant and manager, Industrial Applications Engineering Department, AEI Motor and Control Gear Division, has retired after forty-seven years' service with the company. **Mr. E. L. N. Towle, B.Sc.(Eng.).Lond., M.I.Mech.E., M.I.E.E., M.I.Mar.E.**, succeeds Mr. Pringle as manager, Industrial Applications Engineering Department, Rugby and Manchester. **Mr. G. N. Leech, B.Sc., A.M.I.E.E.**, has been appointed chief engineer, power transformers (Rugby), in the Transformer Division. **Mr. John E. Jordan** has retired from the purchasing department of AEI Manchester, Trafford Park, after 51 years service. He joined the Company in the days when it was the British Westinghouse Company and has worked in the Purchasing Department throughout the whole of his 51 years. **Mr. Harold Diggle, B.Sc., M.I.E.E.**, consultant for the Engineering Department at the Wythenshawe Works of the AEI Transformer Division has retired after forty-six years' service.

BRITISH WELDING RESEARCH ASSOCIATION announces that **Mr. P. T. Houldcroft**, formerly the association's chief metallurgist, now becomes head of the new Welding Technology Department, with **Mr. A. A. Smith**, formerly in charge of the Welding Process Section, as deputy head. Complete administrative responsibility for, and control of, the metallurgical laboratory is assumed by **Mr. H. F. Tremlett**, the deputy director of research, with **Dr. R. G. Baker** and **Mr. J. G. Young** as chief metallurgists in charge, respectively, of ferrous and non-ferrous researches.

"MONITOR" PATENT SAFETY DEVICES Limited announce the retirement of **Mr. C. L. Stokoe, M.I.Mar.E., A.M.I.Mech.E.** Mr. Stokoe, who is 80, founded the company in 1929.

EDGAR ALLEN & CO. LIMITED announce that **Brigadier Levesley, O.B.E., M.C., T.D., M.I.Mech.E.**, has been appointed president of the Welded Tool Manufacturers' Export Association and of the Welded Tool Manufacturers' Association, in succession to **Mr. R. P. Wallace** of Jessop-Saville Limited. **Mr. B. H. Chambers**, manager of the Engineers' Tool Dept., of Edgar Allen & Co. Limited, is a member of the committees of these associations, but he will be succeeded by **Mr. W. V. Oakes** at the end of this year on his retirement from the company.

FOLLOWING the recent resignation of **Mr. A. M. Simmers**, who has taken up an appointment with Vickers Limited, **Mr. P. H. Morwood** is appointed secretary of English Steel Corporation Limited, and **Mr. A. Taylor**, special director, is appointed chief accountant of E.S.C. Mr. P. H. Morwood is also secretary of the U.K. subsidiaries of the E.S.C. group, and Mr. A. Taylor is chief accountant of the wholly owned subsidiaries.

Mr. Joseph Samuels, for six years a member of the board, has been appointed managing director of Winston Electronics Limited, Shepperton, Middlesex. **Mr. W. Allan Bridges** continues as chairman of the board, relinquishing the managing directorship assumed in August, 1961.

Colonel Alan Randall Rees-Reynolds, C.B.E., T.D., has been elected to the board of Pollard Ball & Roller Bearing Company Limited.

Mr. C. J. Evans, A.M.I.E.E., has been appointed southern area sales manager of Efco Furnaces Limited.

WILLIAM BOBY AND COMPANY, water treatment engineers, have appointed **Lt. Comd. C. B. Shirley** to head their production department.

Obituary

WE regret to record the death at the age of 67, of **Dr. Edwin Gregory, M.Sc.(Lond.), A.Met., M.I.Chem.E., M.I.E.I., F.I.M., F.R.I.C.**, a director of Edgar Allen & Co. Limited for 15 years and chief metallurgist from 1944 until his retirement from executive duties in March, 1961.

WE regret to record the death of **Miss Gertrude Lillian Entwistle, A.M.I.E.E.**, one of the first women electrical engineers in this country. From 1915 until her retirement in 1954 she was a designer of d.c. electric motors and generators with Metropolitan-Vickers Electrical Company Limited. Miss Entwistle was a founder member of the Women's Engineering Society (formed in 1919) and was its president from 1941 to 1943.

WE regret to record the death of **Mr. J. P. Gregory, B.Sc.(Eng.), A.M.I.E.E.**, assistant manager at Rugby of the Control Gear Engineering Department, AEI Motor and Control Gear Division.

WE regret to record the death of **Mr. E. P. Grimsdick**, who was with the AEI group of companies for 59 years, and for 48 years played an important part in the industrial development of India.

WE regret to record the death of **Mr. K. L. Oliver** general manager of the David Brown Machine Tool and Tool Divisions, and a director of David Brown Industries Limited.

WE regret to record the death of **Mr. Robert Davidson MacMillan**, managing director of Controlled Heat & Air Limited (a member of the Incandescent group of companies).

Addresses

A NEW company, Site Shotblasting & Painting Company Limited, with headquarters in Commercial Street, Birmingham, has been formed to provide a mobile maintenance service for any site in Great Britain.

THE AEROGRAPH-DEVILBISS COMPANY Limited is now at Ringwood Road, West Howe, Bournemouth. Telephone: Northbourne 1110.

STRACHAN AND HENSHAW LIMITED, Bristol, materials handling plant and nuclear fuel charging equipment, has moved its headquarters to a new office building adjoining the company's Ashton Works, in Ashton Vale Road, Bristol 3.

POLYPENCO LIMITED have recently acquired new office premises at Gate House, Fretherne Road, Welwyn Garden City, Herts.

THE registered offices of both Bladite and Metal Cleaning two subsidiary companies formed by the Castrol Group, are at 2-8 St. Johns Road, Bootle 20, Lancashire.

Contracts and Work in Progress

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—£2½ M. order from British Railways for 57 power equipments. *Heavy Plant Division.* Order valued at £400,000 from G. & J. Weir Limited covering eight 9500-hp, 11,000-volt motors for driving standby boiler feed pumps at Ferrybridge 'C' Power Station. The supply of propulsion machinery and auxiliary electrical equipment for a 1200-shp diesel-electric dredger to be built by Simons-Lobnitz Limited of Renfrew, for the Blyth Harbour Commission. A Norwegian order worth approximately £300,000 for the most powerful waterwheel generator yet to be manufactured in Great Britain. *Motor & Control Gear Division.* Supply of all the electrical equipment, valued at £150,000

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Light job or heavy, solid material or cavity, Rawlplug Fixing Devices make every screw or bolt fixing easy and straightforward—even the 'impossible' ones! Just look at these examples.

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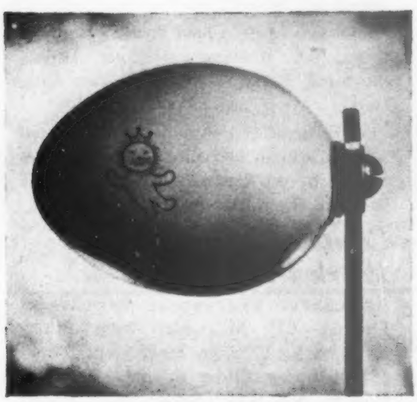
Here's strength again! In Hong Kong, normal tackle failed to lift 5-ton boulders from a 20 ft. deep pit. Solved by drilling to take a 'K' size Rawlbolt with 1" diameter eyebolt. Nothing approaches Rawlbolts for strength, ease and speed—no cold chiselling, no grouting in, no waiting for cement to harden.

CAVITY FIXINGS . . .



Can you imagine a more difficult cavity material than an eggshell? Yet here it is, screw-fixed with a Rawlnut! Use the appropriate Rawlplug Fixing Device—there are 24 different types—and you'll have no trouble with thin or hollow materials. And you'll save a lot of time!

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MILLIONS ARE USED EVERY WEEK THROUGHOUT INDUSTRY

for two cotton ginning and baling factories for the Sudan Gezira Board.

THE UNITED STEEL COMPANIES LIMITED.—Installation of a Concast continuous casting machine at Round Oak Steel Works of Tube Investments Limited, Brierley Hill, Staffs.

WILLIAM BOBY LIMITED.—A £23,000 contract for the supply of an automatic demineralization plant at a new acrylic fibre factory in Yugoslavia, awarded by Courtaulds Limited.

THE ENGLISH ELECTRIC COMPANY LIMITED.—A £4 M order to supply two 350 MW steam turbines for the Munmorah power station, New South Wales, Australia, awarded by the Electricity Commission of New South Wales. The first machine is scheduled to go into commercial operation in November 1966, and the second a year later.

DAVID BROWN INDUSTRIES LIMITED, Park Works, Huddersfield.—A 50-ton double helical gear unit, one of four units ordered by Lamberton and Company Limited, of Coatbridge, Scotland, for a rolling mill to be installed by Pacific Steel Mills, New Zealand, was recently despatched.

VICKERS RESEARCH LIMITED.—Supply of a 6 million volt X-radiographic unit to English Steel Corporation Limited, Sheffield. The unit incorporates a 6 "MEV" sealed off linear electron accelerator.

LAURENCE, SCOTT & ELECTROMOTORS Limited.—Contract worth more than £500,000 for the supply of electric motors and control gear for use in connection with the manufacture of polythene by a group of four Eastern European countries.

GENERAL ELECTRIC COMPANY (ENGINEERING) Limited.—Order from Millspaugh Wimpey Limited, for a 7 MW double-passout condensing turbo-generating set for installation in a pulp and paper mill at Plaski, Yugoslavia.

BRIGHTSIDE HEATING AND ENGINEERING Company Limited, Sheffield.—Contract to instal Brightrad radiant strip and unit heaters with fresh air inlets in the Warrington distillery of G. and J. Greenall Limited.

Order to instal heating and engineering services in the new refectory block of King's College, Newcastle-upon-Tyne. The installation will include floor and ceiling heating, with plenum heating to the refectory building.

THE ENGLISH ELECTRIC COMPANY LIMITED.—The Grand River Dam Authority of Oklahoma, U.S.A. has awarded the English Electric Corporation of New York a contract worth some $2¼ m. (£900,000) for four 35,000 hp., 90 rpm, Kaplan water turbines with a runner diameter of 220 ins.—for a new dam and power station on the Grand River at Markham Ferry, Oklahoma.

Order worth over £120,000 for 1450 s.h.p. twin screw, diesel-electric propulsion installation for the new District Tender Vessel to be built by J. Samuel White & Co. Limited, for Trinity House.

General view of the machine tool exhibition held recently at the showrooms of the Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2. This was visited by representatives of well over 400 companies and a large number of individuals, as well as organized parties of students from technical schools and colleges and apprentices from engineering companies

Contract worth about £300,000 for the major part of the electrical equipment in a new pulp and paper mill to be built in Yugoslavia has been awarded to English Electric by Millspaugh-Wimpey Limited.

£300,000 order for generating equipment for Tanganyika's largest hydro-electric station.

Order worth over £330,000 for diesel-alternator sets for the Commission Federal de Electricidad of Mexico received by the Diesel Engine Division of English Electric.

WILD-BARFIELD ELECTRIC FURNACES Limited.—Order for two gas carburising furnaces from Crofts (Engineers) Limited, of Thornbury, Bradford.

Further order for mains frequency induction heated equipment for Japan.

Supply of high frequency induction heating equipment for Horstman Limited.

Order for an SF.12X shaker hearth furnace and ancillary equipment from British Pens Limited of Smethwick for the heat treatment of small springs etc.

W. H. ALLEN SONS AND COMPANY Limited, Bedford.—Contract from the Southend Waterworks Company valued at approximately £38,000 covering pumping plant for the Nevendon Booster Station.

Business Developments

Company Acquisitions

THE AEI-JOHN THOMPSON NUCLEAR Energy Company, which already holds 50% of the shares of Nuclear Graphite Limited, is to acquire the other 50% from The Morgan Crucible Company Limited.

EDGAR ALLEN & CO. LIMITED, who have held a minority interest in the capital of the Sheffield Hollow Drill Steel Company Limited for many years, have now acquired the remainder of the issued capital, and the company now becomes a wholly-owned subsidiary within the Edgar Allen Group.

Trading Agreements

SHEPPARD & SONS LIMITED, heavy precision engineers of Bridgend, Glamorgan, have entered into a sole manufacturing and sales licensing agreement for the United Kingdom Europe and elsewhere, for the Scrapmaster range of hydraulically-operated shears and baling presses for scrap processing developed by Harris Foundry and Machine Company of Cordele, Georgia, U.S.A.

Film News

Colour Today.—Produced by Cygnet Film Productions for Pinchin Johnson & Co. paint products, this film surveys the whole field of colour and includes a section on the Munsell Colour System and the heating of metals and pigments. In Ektachrome with full sound it runs for 20 minutes.

Tufnol in the Making. The manufacturing processes of laminated plastics is the subject of this 16 mm film, which is on a free loan basis, and is a tour of the Tufnol factory. Application for copies may be obtained from Tufnol Limited, Perry Barr, Birmingham 22B, or from the Central Office of Information Film Library.

The Way of Kings.—This is the second film made for Geo. W. King Limited, materials handling specialists, and shows the working equipment at the Vauxhall plating plant at Luton, the Perkins diesel engine factory at Peterborough and the Sainsbury egg packing station at Kenninghall. 16 mm black and white, running time of 22 min. Available on free loan on application to the Publicity Manager, Geo. W. King Limited, Stevenage, Herts.

Motors by the Million.—Another film by Brook Motors Limited, dealing with the company's new factory for the production of fractional horsepower motors. Available on free loan from the publicity department of Brook Motors at Huddersfield. 16 mm, in colour, running time 16 min.

Quenching Fluids

Sternol Limited, Royal London House, Finsbury Square, London EC2, have issued a short technical booklet "The Modern Method of Quenching Steel" by E. T. Gill, B.Sc., F.I.M. This outlines the hardening and quenching processes and gives details of the quenching media made by the company. A number of useful tables are also included.

Ice Plugs for Pipes

Drikold is the trade name of I.C.I's solid carbon dioxide which has a temperature of approximately —110° F, i.e. 142° colder than ice. One of its many uses as a refrigerant is to form ice plugs in water pipes so that the sections of pipe requiring repair or replacement can be isolated. A short booklet giving fuller information can be obtained from Imperial Chemical Industries Limited, Millbank, London SW1

Bearing Units

An illustrated folder from Pollard Bearings Limited, Ferrybridge, Knottingley, Yorks., deals with the latest range of 'Self-Lube' ball bearing units and their application in many fields, including shipbuilding, highway engineering, agriculture, coal-mining etc.

Electronic Equipment

A folder, describing the frequency spectrum of the electronics industry, which should prove helpful in relating the continuous flow of new developments to their proper significance within this field, has been issued by Raytheon Company, Lexington 73, Massachusetts, U.S.A. Details of the company's products are also included.

Humidity Instruments

A 16-page leaflet (List 70/1) issued by the Cambridge Instrument Company, 13 Grosvenor Place, London SW1, describes their range of hygroscopic and wet and dry bulb humidity indicators, recorders, and controllers, The publication also provides general information on several humidity control systems and contains a short bibliography relating to other sources of information on the measurment and control of humidity.

Hydraulic Multipresses

Denison hydraulic multipresses, series "R", "S" and "T" are now being built in Britain by Denison-Deri of Victoria Gardens, Burgess Hill, Sussex. Descriptive literature is available from Gaston E. Marbaix Limited, Devonshire House, Vicarage Crescent, London SW11.

"Molybdenum Disulphide in Action"

The second edition of the booklet of this title, contains a number of new reports on applications of molybdenum disulphide, and also retains many of those published in the first edition. Copies of the new edition are available on request to engineers interested in solid lubrication by molybdenum disulphide from K. S. Paul (Molybdenum Disulphide) Limited, Angel Road, London N18.

Flat Transmission Belting

The new "flat transmission belting" catalogue issued by Turner Brothers Asbestos Company Limited, P.O. Box 40, Rochdale, contains a considerable amount of information on the use of their square edge and rounded edge rubber belting, hammer mill and tractor belts, balata and fire resisting belting, and whipcord belts, belt fasteners, on drive design and the operation of flat belts. Also given are power capacity data, tables for recommended pulley diameters, number of piles required, arc of contact factors, and the circumference of pulleys for a given diameter.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Hicycle tools

An eight-page catalogue of Hicycle high frequency electric tools, produced by the Consolidated Pneumatic Tool Company Limited, of 232 Dawes Road, London, SW6, gives in concise form, full details and specifications of the complete range of over 90 tools for high frequency electric operation including drills, screwdrivers, wrenches, nut runners, tappers, grinders, sanders and polishers.

Bakelite Gears

In addition to their strength and elasticity, Bakelite laminated gears are resistant to most acids and mild alkalies and will operate satisfactorily in the presence of oil, water or steam. An illustrated booklet "Bakelite Laminated for Gears" from Bakelite Limited, 12 Grosvenor Road, London SW1, describes the material, the applications to which it is suited, installation principles, and gives all relevant formula and data.

Closed-circuit television

By providing a means of visual inter-communication for industrial, commercial and scientific uses, closed-circuit television installations can save time and money. This is the theme of a new pamphlet published by EMI Electronics Limited, Hayes, Middlesex. The same company has also published a booklet on ancillary equipment varying from remote iris control to camera acoustic housing.

AB De-ion Circuit Breakers

The Westinghouse Electric Corporation's 'AB De-ion' moulded case circuit breakers, are designed for circuit protection of low voltage distribution systems, and are suitable for application as main breakers and for protection of branch and feeder circuits and connected apparatus in control boards, control centres, panel boards, combination starters and separate individual enclosures. These are are now manufactured under license by Chilton Electric Products Limited, Hungerford, Berks., who have several items of literature available.

Beryllium

'Beryllium—The new light metal', a publication issued by Consolidated Zinc Corporation (Sales) Limited, 6 St. James Square, London SW1, on behalf of its associated company, Consolidated Beryllium Limited, outlines the combination of properties of this metal which have led to diverse uses in nuclear reactors, missiles and precision instruments. These include low density, low neutron absorption, high thermal conductivity, high specific heat and high elastic modulus.

Effluent Analyser

The Evershed Mark 200 Polarograph which offers a fast and accurate method of making chemical analyses and can be used by semi-skilled personnel is recommended by the makers for measuring impurities in effluent. A leaflet giving details is available from Evershed and Vignoles Limited, Acton Lane, London W4.

Catalogues Received

Hilflon Ptfe hose and thread sealing tape. Hilflon swivel joint. William Rose Limited, Lockfield Avenue, Brimsdown, Middx.

Office lighting schemes. Philips Electrical Limited, Shaftesbury Avenue, London WC2.

Multiflex Record motor and accessories, Loughborough Glass Company Limited, Loughborough, Leicester.

Standard cylinders and control valves. Consultair Limited, Handsworth, Birmingham 19.

Omark—Graham stud welding system. Omark Industries Inc., 9701 S.E. McLoughlin Blvd., Portland 22, Oregon, U.S.A.

RolaVeyor conveyor. J. Collis & Sons Limited, Gray's Inn Road, London WC1.

Flamestat automatic oil burner control type FF100. Radiovisor Parent Limited, Stanhope works, High Path, London SW19.

Hewleth-Packard 524C 10 Mc/s electronic counter. Livingston Laboratories Limited, 31 Camden Road, London NW1.

Hot pressings in brass, light alloy and aluminium bronze. Brass & Alloy Pressings (Deritend) Limited, Birmingham 9.

Plastic signs. Bribond Signs Limited, Burgess Hill, Sussex.

Commander KH series bell-operated low-head instruments for measuring flow and differential pressure. Commander KB series bellows-operated level and pressure instru-

ments. ST/L manometer spare-parts list. Miniature universal primary elements. Standard ranges Multelec Mark 2 temperature instruments. George Kent Limited, Luton.

Packing cases. Fir Plywood Newsletter, Plywood Manufacturers Association of British Columbia, 1 Grosvenor Square, London W1.

Correction. In this column in our December issue in the item commencing "Copper roofing" the name of the company should have been "The Ruberoid Co. Ltd."

Ashington (Northumberland). A Reyrolle and Company Limited, switchgear manufacturers, Hebburn-on-Tyne, are considering extensions to their works at Ashington.

J. Hepworth and Son, Claypit Lane, Leeds, 2, are to erect a clothing factory and offices near the Jubilee Estate and outline plans by the firm have been approved.

Billingham-on-Tees. Calor Gas Company Limited, Great Portland Street, London W1. Plans for storage accommodation at Port Clarence have been prepared by J. E. Myers, 20 Finkle Street, Stockton-on-Tees.

Castle Ward (Northumberland). A. Alderson and Company, 148 High Street West, Sunderland, are to erect wool store, packing and despatch departments, and offices on the Ponteland industrial site. No contracts let. The architects are Matkin and Hawkins, Barclays Bank Chambers, Fawcett Street, Sunderland.

Durham. Irvine Electrical Services Limited. Plans for a depot at Church Street, Durham, have been prepared by Doffman and Leach, 17 Wolverhampton Road, Stafford.

Gateshead. The British Transport Commission have started preliminary work on a new £1,000,000 freight terminal. Derek Crouch, Limited, Station Road, Birtley, are preparing the site, and Wright Anderson and Company Limited, Gateshead, are to erect two large sheds.

Elders, Walker and Company are to convert the disused Palace Cinema into a glass plate cutting shop. The architect is J. M. Angus, 3 Gallowgate, Newcastle upon Tyne.

Clarke, Chapman and Company Limited, Gateshead. The contractors for proposed extensions to research buildings are Brims and Company Limited, Pandon Buildings, City Road, Newcastle upon Tyne.

Newburn (Northumberland). British Bakeries Limited, London. A bakery is to be erected by Wimpey and Company Limited, Fenwick Terrace, Newcastle upon Tyne.

K. and L. Steelfounders Limited, Letchworth. Factory additions are proposed. The contractors are Tarmac Civil Engineering Limited, Bowesfield Lane, Stockton.

South Shields. Elsey and Gibbons Limited, engineers. The contractors for factory additions are Milton Swales Limited, Imeary Street, South Shields.

Spennymoor. Remploy Limited. New factory. The builders are Bell and Ridley Limited, North Road, Durham.

Tynemouth. John Lilley and Gillie Limited, compass makers, New Quay, North Shields, are to erect new premises at Olive Street, North Shields, to replace their present premises which are to be demolished The architects are G. H. Gray and Partners, Camden Street, North Shields.

Washington (Co. Durham). Washington Chemical Company Limited. Approval for proposed offices and laboratories has been received. Plans are by Powell Duffryn Limited, Proctor House, The Side, Newcastle upon Tyne.

Accrington. R. P. Townley & Son Limited. Extensions are to be made to the works at 148 Burnley Road.

New Factories

Ampthill. Interlas Limited, Church Street, are to build a new factory in Station Street.

Bedford. W. H. A. Robertson & Co. Limited. The architects for extensions to the works in Ampthill Road are Elliott, Cox & Partners, 172 Buckingham Palace Road, London SW1.

Blackpool. Lancashire Cash Bakery Limited, Threlfall Road, to erect new premises at Preston New Road.

Bolton. Black, Taylor & Cowell Limited Starkie Works, Starkie Road, are to be extended.

Builth Wells. Webb, Corbett Limited, Coalbourn Hill Glass Works, Stourbridge, are considering the erection of a new factory.

Castlederg. Co. Tyrone. J. Scott & Co. Limited, Main Street, are to have a new factory built.

Cheltenham. Taylor, Young (Printers) Limited, 79 Clarence Street. New printing works. The architects are L. W. Barnard & Partners, 18 Imperial Square.

Coventry. Coventry Climax Engines Limited, Godiva Works, Widdrington Road. Plans have been approved for the erection of a new factory.

Croydon. London Engineers Pattern Company Limited, Waddon Marsh Way. Factory extensions.

Trojan Limited, are to extend their works in Purley Way.

Dagenham. Green & Dyson Limited, are to build a new factory at Fowler Road, Hainault.

Doncaster. Montague Burton Limited. Plans have been approved for the erection of factory extensions at Wheatley Hall Road.

Dover. B. M. Gheysens Limited, Buckland Bridge. L. R. Barlow, 32 Millwall Place, Sandwich is the architect for the new factory.

Exmouth. C. &. J. Clark Limited, Street, have received planning permission to erect a new factory in Salterton Road.

Folkestone. F. W. Maul & Son, 78 Tontine Street. A new factory is to be erected near Biggins Wood Road.

Hastings. Hammond Bros. Upper South Bank Road, St. Leonards-on-Sea. A new factory is to be built at Windmill Avenue.

Hayes. British Electric Transformer Company Limited, Clayton Road. The architects for extensions to the factory are Adie, Button & Partners 7 Carlos Place, London W.1.

High Wycombe. E. M. F. Brown Limited, Duke Street. The architects for the new factory are Thurlow, Lucas & James, 86 Easton Street.

Hull. Parsons Bros. Extensions are to be made to the factory in Froghall Lane.

Ilfracombe. The Lion Case Company Limited, London, are applying for permission to build a new factory.

Leamington Spa. Glass Sealer Company Limited, Everseal House, Queensway. A new factory is to be built on the Queensway Estate.

Leeds. L. Rakusen & Sons Limited, 20 Meanwood Road. Factory extensions.

Liverpool. Bradley's (Chester) Limited. A new factory is to be built at St. James Street.

London. Marsh Vick & Co. Limited. Extensions are to be made to the Dulcia Mills, Herbert Street.

Bowden Engineering Limited. The architects for the new factory and offices to be erected at Park Lane, London E15, are Oxley & Burgess, 1 Como Street, Romford.

H. Fine & Son, 5 Vale Road, London N7, are to erect a new factory.

Luton. Ketton Ashwell Limited. A new factory and offices are to be built at Arundel Road.

Barclay Stuart (Plastics) Limited, are to make extensions to their factory.

Manchester. Britannia Quilt Company Limited, Wilmslow Road, Rusholme, are to extend their factory.

Penrith. Gush & Dent Limited, are to make extensions to their works.

Redditch. Extensions are to be made to the factory in Britten Street for the Regent Rod Company Limited.

Bentley Engineering Company Limited, are to extend their works at Birchfield Road.

Slough. Hazel, Watson & Viney Limited, Leigh Road. Extensions are to be made to the factory.

Southwick. Ericsson Telephones Limited, North Hylton Road. Plans have been approved for factory extensions.

Stretford. British Arkady Company Limited. The works at Skerton Road are to be extended.

Surbiton. High Speed Service Tool Company Limited, Maple Road, are to build new premises at St. James Road.

Field Bros., Cox Lane, are to make extensions to their works.

Swanscombe. Paper Sacks Limited, Esander Road. Extensions are to be made to the factory.

Teddington. Grundy (Teddington) Limited, Somerset Road, are to rebuild and extend their works.

Tisbury. (Wilts). Dinnodog Products Limited, have received permission to erect a new factory in Duck Street.

Walsall. Brownhills Sheet Metal Company Limited, Camden Works. Plans have been approved for the erection of a new factory at Coppice Road, Walsall Wood.

Warrington. Metro-Cutanit Limited, Allen Street. The architects for the new factory at Grappenhall are J. W. Beaumont & Sons, 51 Mosley Street, Liverpool.

Watford. R. & J. Beck Limited. A new factory is to be erected at Greycaines Estate, Bushey Mill Lane.

Wimbledon. Whitton Precision Company, Bridge Works, Durnford Road. The architects for extensions to the factory are Lush & Lester, 121 Kingsway, London WC2.

Aberdeen. Remploy is planning to increase its factory space by some 50 per cent. Other Remploy developments are planned for Dalmuir and Buckhaven. Knitwear will be produced in these centres.

Newbattle, Midlothian. Norberry Instrument Company Limited of Surrey are planning development of a 10,000 sq ft factory at Newbattle making electronic testing gear and domestic heating appliances.

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THE proprietor of British Patent No. 780224, entitled "Hinged Lid Oiler", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 759067, entitled "Wide Throat Press" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietors of Patent No. 777853 for "Improvements in or relating to Load Hooks for lifting" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London, W.C.2.

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THE proprietor of British Patent No. 753062, entitled "A method and apparatus for forming a true cylindrical surface on an elongated member, such as a crankshaft or a calender roll", offers the same for license or otherwise to ensure practical working in Great Britain. Inquires to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

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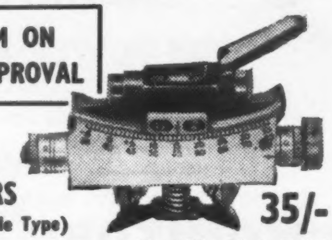

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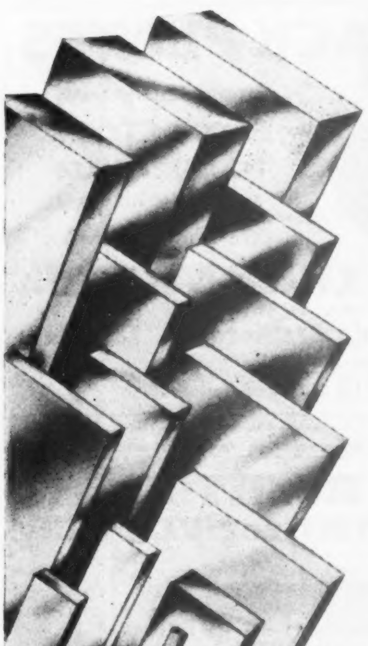

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